CHAPTER 5

Risk Analysis of Species in Old-Growth Forests of the Pacific Northwest: Viability Assessment and Mitigation Measures in National Forests

CHAPTER 5

Risk Analysis of Species in Old-Growth Forests of the Pacific Northwest: Viability Assessment and Mitigation Measures in National Forests

Table of Contents

Appendices

List of Tables

List of Figures

CHAPTER 5

Risk Analysis of Species in Old-Growth Forests of the Pacific Northwest: Viability Assessment and Mitigation Measures in National Forests

INTRODUCTION

Court Order

This chapter addresses the portion of the United States District Court order to evaluate the effect of proposed management strategies for the northern spotted owl (*Strix occidentalis caurina*) in National Forests on viability of other species of plants and animals closely associated with old-growth forests. Specifically, the Scientific Analysis Team's tasks were: (1) to determine if the alternatives for management of northern spotted owl habitat as presented in the Forest Service's Final Environmental Impact Statement on Management for the Northern Spotted Owl in the National Forests (USDA 1992c)(hereafter referred to as the Final Environmental Impact Statement) would allow alterations of habitat that would result in the extirpation or extinction of any of the 32 vertebrate species associated with old-growth forest in National Forests within the range of the northern spotted owl, as identified in the Final Environmental Impact Statement and in the Judge's order; and (2) if analyses indicate low viability ratings for such other species as a result of the proposed actions, to propose appropriate mitigating options (Forest Service letters of direction dated July 30, 1992 and August 28, 1992; see Chapter 2, Appendix 2-A).

Framework for Assessment

Our evaluation of species associated with old-growth forests and their viability entailed three phases:

Identification of species closely associated with old-growth forests and components of old-growth forests;

Evaluation of the viability of each of these species, under each of the five alternatives in the Final Environmental Impact Statement, including estimating the likelihood of extirpation from planning areas (i.e., National Forests) within the range of the northern spotted owl; and

Identification of mitigation options to ensure a high likelihood that each species would not be extirpated from planning areas within the range of the northern spotted owl as a result of Forest Service actions.

This process also entailed identifying scientific uncertainties and key unknowns that could influence the viability evaluations of old-growth forest species. Such unknowns included identifying species about which little or no scientific information on ecology, life history, and habitat relationships is available.

Risks to each species associated with old-growth forests in terms of extirpation and viability were judged by the alternatives in the Final Environmental Impact Statement. In estimating habitat associations and risks of extirpation, the Scientific Analysis Team was not expected to conduct a formal viability assessment for each forest species associated with old-growth forests. Rather, we were directed to use common sense and expert judgment and to explicitly display and discuss the process used for establishing viability ratings (Forest Service letter of direction dated August 28, 1992; see Chapter 2, Appendix 2-A; also see court order discussed in Chapter 1).

METHODS

Description of the Northern Spotted Owl Final Environmental Impact Statement

Viability of species closely associated with old-growth forests was evaluated under each of the five planning alternatives presented in the Final Environmental Impact Statement. These alternatives applied only to National Forests. They were:

A - Spotted Owl Habitat Areas
B - Interagency Scientific Committee's Conservation Strategy (Thomas et al. 1990)
C - Interagency Scientific Committee's Conservation Strategy plus Fish and Wildlife Service's (USDI) critical habitat designated for the northern spotted owl
D - Interagency Scientific Committee's Conservation Strategy plus all additional nesting, roosting, and foraging habitat for northern spotted owls
E - The Multi-Resource Strategy

Standards and Guidelines of the Selected Alternative

The selected alternative in the Final Environmental Impact Statement was Alternative B-the Interagency Scientific Committee's Conservation Strategy. This strategy entails designation of Habitat Conservation Areas to encompass nesting, roosting, and foraging habitat for the northern spotted owl throughout its range in National Forests (see Chapter 3).

In addition, the forest "matrix" (lands between the Habitat Conservation Areas) are to managed to provide for northern spotted owl dispersal habitat. Management guidelines for providing dispersal habitat are termed the "50-11-40 rule" (Thomas et al. 1990). This standard provides for each quarter-township outside of Habitat Conservation Areas in National Forests and other Federally administered public lands within the range of the northern spotted owl, at least 50 percent of the forested land base in forest stands averaging at least 11 inches diameter at breast height (dbh) and at least 40 percent canopy closure. Also, the Interagency Scientific Committee's Conservation Strategy calls for the retention of other land allocations that also provide for old-growth forest cover, as identified in each National Forest Land and Resource Management Plan.

Old-Growth Species Identified in the Final Environmental Impact Statement

The Final Environmental Impact Statement identified 32 species of terrestrial vertebrate wildlife (amphibians, reptiles, birds, and mammals) that are closely associated with late-successional or old-growth forests or components of old-growth forest (see Final Environmental Impact Statement, Volume 1, p. 3~4-136, Table 3&54-30, "Species Closely Associated With Late-Successional Forest"). Our analysis refined the basis for evaluating the degree of association of these species with late-successional and old-growth forests, and expanded the evaluation to include fungi, lichens, plants, invertebrates, and fish, in addition to all terrestrial vertebrates.

Why Evaluate All Species Groups?

We considered a wider range of plant and animal species than that presented in the Final Environmental Impact Statement for three primary reasons. First, selecting and implementing a spotted owl habitat management plan is best conducted from a base of full disclosure and knowledge of potential effects of that plan on all species. Second, assessing effects on a broad variety of species groups better meets agency direction to provide for, and evaluate impacts on, the full range of biological diversity. Third, such a comprehensive approach lays the groundwork for a more complete approach to ecosystem management. Identification of effects on, and mitigation options for, individual old-growth species is still but one step in ecosystem planning. We do not intend for this assessment to substitute for a complete ecosystem analysis; it is, however, a vital and major step toward such an analysis.

Furthermore, the Court identified that "Congress's mandate for multiple use, including both logging and wildlife preservation, can be fulfilled if the remaining old-growth habitat is left standing; it cannot be if the old growth in any National Forest is logged to the point where native vertebrate species cease to exist there" (Judge Dwyer's ruling of July 2, 1992). Our assessment was conducted to help the Forest Service determine steps necessary to safeguard the security of old-growth forest species occurring within the range of the northern spotted owl.

Selection of Old-Growth Species

The following procedure was used to identify species closely associated with old-growth forests. We compiled a "long list" of species that occur within late-successional forests (mature or old growth, as defined by Ruggiero et al. 1991, Brown 1985, USDI 1992a). This long list was narrowed to a "short list" of species closely associated with old-growth forests or with components of old-growth forests. Each species on this short list was then evaluated for viability under the Final Environmental Impact Statement alternatives, and subset lists of species with risk to viability were identified. Also, species were identified that are so poorly known scientifically that viability could not be judged. Mitigation options for the species with risk to viability were then identified. Specifically, each step in this process was conducted as follows.

"Long List" of Species That Use Mature and Old-Growth Forests - First, we identified all plant and animal species that might find optimal habitat within late-successional forests in National Forests within the range of the northern spotted owl. In this step, we reviewed available summaries of literature on species distribution by forest condition and age class (see literature cited in Appendix 5-A). We also accessed unpublished studies and data, existing Forest Service data bases (ecology data bases), and used professional knowledge to compile the long lists plants. The technical and scientific literature contains many references on species occurring in

late-successional forest (see citations in Appendix 5-A). We did not attempt to review every existing piece of primary literature; rather, we focused on the major syntheses of mature and old-growth species lists most often cited and used by resource managers and biologists (Appendix 5-A). Of particular importance in building the long lists were the recent publications of Ruggiero et al. (1991) and the Draft Recovery Plan for the Northern Spotted Owl (USDI 1992a).

We compiled a composite list of all species that were depicted in one or more of these references as using late-successional forests within the range of the northern spotted owl for at least one aspect of their life history. This resulted in a "long list" of plant and animal species found in late-successional forests (see Appendix 5-A). A long list of 7 anadromous fish species consisting of 214 stocks, and an additional 4 species of resident fish, were considered by the fish habitat experts on the Scientific Analysis Team. A stock is a locally adapted population that is, for the most part, reproductively isolated from other stocks (Packer 1972). Individual stocks have been recognized for listing under the Endangered Species Act (National Marine Fisheries Service 1990). In this report, conservation mitigation options focused on the identified stocks.

"Short List" of Species Closely Associated With Old-Growth Forests - We then developed a set of criteria by which each species on the "long list" was further evaluated for its degree of association with old-growth forest ecosystems (Table 5-1). Not all species on the long list are closely associated with old-growth forests; some species also occur commonly in young-growth forests, or in other special habitat Conditions. The criteria we developed helped identify those species that are associated with old-growth forest stages and old-growth forest components such as large snags and large down logs plus those species identified by state or Federal agencies as proposed or listed as threatened or endangered. The criteria helped us to produce a "short list" of species likely to be closely associated with old-growth forests or components of old-growth forests (see Appendices 5-B, 6-C, 6-D; also, Appendix 5-A shows how the criteria were applied to each species of terrestrial vertebrate on the long list).

Components of old-growth forests considered in this evaluation included large diameter snags, large diameter and very old live trees, large amounts and sizes of down wood, and deep litter and duff layers on the forest floor. We explored species' use of old-growth forest components because these are elements of forest ecosystems that possibly could be provided outside old-growth forests per se by use of innovative silviculture. These old-growth forest elements are key to the dispersal and distribution of some species across the general forest landscape.

Table 5-1 Criteria for Developing the List of Species Closely Associated With Old-Growth Forests or Components of Old-Growth Forests ("Short List"), From the List of Species That Least Occur Within Old Growth ("Long List").

Criteria

A species is included in the short list of species closely associated with old-growth forests or components if it meets at least one of the following 4 criteria:

Criterion 1:	- The species is statistically significantly more abundant (based on field study or collective professional judgment of the Scientific Analysis Team) in old-growth forest than in pole or mature forest, in any part of its range.
Criterion 2:	- The species shows association with old-growth forest (may reach highest abundance there, but not necessarily statistically so) and the species requires habitat components that are contributed by old-growth forest (based on field study or collective professional judgment of the Scientific Analysis Team).
Criterion 3:	- The species is associated with old-growth forest (based on field study) and is on Federal (Fish and Wildlife Service) or state threatened and endangered List, on the Fish and Wildlife Service Candidate Species List, Forest Service Regions 5 or 6 Sensitive Species List, or listed by Washington, Oregon, or California as species of special concern or sensitive species.
Criterion 4:	- Field data axe inadequate to measure strength of association with old-growtli forest, and the species is listed as a Federal (Fish and Wildlife Service) threatened and endangered, and Scientific Analysis Team suspects that it is associated with old-growth forest.

Specific Factors

Following are specific factors extracted from the above list of criteria. These factors were identified for e~ch terrestrial vertebrate species (amphibians, reptiles, birds, and mammals) on the long list (see Appendix 5-A; similar procedure was used for plant species and fish stocks, not shown in the appendices).

Factor A-	-Field data: species is significantly more abundant in old-growth forest than in younger forest based on field data.
Factor B-	-Scientific Analysis Team judgment: species is significantly more abundant in old-growth forest than in younger forest based on collective professional judgment of the Scientific Analysis Team.
Factor C-	-Association with old-growth forest: species is associated with old-growth forest (may reach highest abundance there, but not necessarily statistically so).
Factor D-	- Associated with old-growth forest elements: species is associated with habitat elements that are contributed by old-growth forest (based on field study or collective professional judgment of the Scientific Analysis Team).
Factor E-	-Federal Fish and Wildlife Service threatened and endangered: species is on Federal (Fish and Wildlife Service) list of threatened or endangered species.
Factor F-	-Federal Fish and Wildlife Service Candidate: species is on Federal Fish and Wildlife Service Candidate Species List.
Factor G-	-Forest Service Sensitive Species: species is on Forest Service Region 5 or 6 Sensitive Species List.
Factor H-	-State list: species is on state list (threatened and endangered, sensitive, special concern) Washington, Oregon, or California.
Factor I-	-Inadequate field data: unaware of adequate field data by which to measure (quantify) strength of association with old-growth forest.

Table 5-1 (continued) Criteria for Developing the List of Species Closely Associated With Old-Gr0wth Forests or Components of Old-Growth Forests ("Short List"), From the List Species That at Least Occur Within Old Growth ("Long List").

Rule Set for Determining "Short List"

Relating factors to criteria - a species qualifies as a ~short llsts species under a given criterion if it strictly meets the following factor conditions:

Meets Criterion 1 if meets: Factor A or B.
Meets Criterion 2 if meets: Factors C and D.
Meets Criterion 3 if meets: (Factor A or C) and (E or F or G or H)
Meets Criterion 4 if meets: Factors E and I and (A or B or C or D).

Assessment of Viability Effects

Population viability analysis can be a complex series of quantitative evaluations. It can involve field data on demography and trend of populations, calculations of loss of genetic variation, and simulation models projecting habitat conditions, population responses, dynamics of metapopulations (interacting populations), and complicating, cumulative effects of other biological and nonbiological factors. Our evaluation of potential viability of old-growth species is not a quantitative population viability analysis. We lack data and specific models of habitats and populations by which to quantify likelihoods of extirpation and continued existence. Our emphasis was qualitative and focused on amount and distribution of habitat provided under planning alternatives. Given more time, we could have considered additional primary literature on some species. However, there are few basic scientific studies on life history and ecological requirements of most species examined.

Based on our collective professional judgment and that of the expert review panels (see below), we qualitatively considered potential future effects Of natural catastrophes and disturbances on species viability. However, because of lack of time and available models, we did not quantify and predict specific aspects of ecosystem process and function, such as by analyzing the type, frequency, and potential effects of disturbance events (i.e., fires, windstorms, outbreaks of forest pathogens, and natural succession). Thus, the viability evaluations presented should be interpreted as qualitative assessments of potential, longer-term effects of implementing habitat management plans for northern spotted owls, rather than as quantitative, statistical analyses of species' demographics and population trends. Likewise, our viability evaluations are not precise quantifications of extinction likelihoods. We fully expect that results of viability assessments for some species will change with availability of more precise data and quantitative models of populations or their environments.

Ecological Characteristics of Species - The following information was used in evaluating potential viability effects. Life history, ecological characteristics and legal listing status were compiled for each species on the short list.

In addition, range maps of the geographic distribution of each species on the short list of terrestrial vertebrates were obtained and entered into a Geographic Information System. The extent of each species' range within that of the northern spotted owl was superimposed onto

maps of reserved areas (such as congressionally designated Wilderness) and designated areas managed primarily for spotted owl habitat under each of the five planning alternatives in the Final Environmental Impact Statement. This analysis helped determine the general extent of the distributional range of each species on the short list that would be protected by (1) designated and reserved spotted owl habitat, and (2) forests outside of designated areas classified unsuitable for timber harvest.

Effects of Land and Resource Management Plans on Old-Growth Distribution Over Time - Also used in the evaluation was information on distribution and abundance of northern spotted owl habitat and old-growth forest cover under each of the five Final Environmental Impact Statement alternatives and as influenced by individual Land and Resource Management Plans from each National Forest. We used information from National Forests in Washington and Oregon on distribution of old growth as assessed with the previous inventory contracted with Pacific Meridian Resources (PMR). We also used the current land management allocations (full timber production, partial timber production, and no timber production allocations) from individual Land and Resource Management Plans from National Forests in Washington and Oregon as affecting the PMR old-growth categories (large old growth, small old growth, and other conifer) in each National Forest. Such data, along with maps of PMR old growth throughout the region and maps of each' National Forest's Land and Resource Management Plan, helped us discern the potential amount and arrangement of old-growth forest cover atpresent and over time that would be provided by individual forest plans in concert with that provided under each planning alternative presented in the Final Environmental Impact Statement.

Fish Experts' Evaluations - Viability of habitat for the anadromous salmonid stocks was evaluated by two members of the Scientific Analysis Team (Reeves and Sedell). Mitigation options for these stocks were developed in coordination with the Forest Service's Pacific Salmon Workgroup and Field Team (also known as "PacFish," USDA 1992a).

Expert Panel Evaluations - We convened a set of five expert panels to evaluate viability of the "short list" old-growth species. The panels evaluated risk of extirpation for each species by planning alternative from the Final Environmental Impact Statement. Each panel was made up of seven to eight recognized experts on (1) fungi, lichen, and nonvascular plants, (2) vascular plants, (3) amphibians and reptiles, (4) birds, and (5) mammals (Appendix 5-E).

In the course of their viability evaluations, the panels considered information on life history and ecological characteristics of each species (including information in Appendix 5-D), range maps of each vertebrate species, and the expected influence of each of the five planning alternatives on spotted owl habitat and old-growth forest cover over time. Each panel also considered each species in various portions of its range, and evaluated viability in each area separately, if the species was distributed in a disjunct (noncontiguous) pattern and would incur different risks viability in each area.

As a result of the panel deliberations, short lists used at the start of the assessment process were modified for nonvascular plants, vascular plants, amphibians, and mammals. Modifications reflected the panels' additions of species, or distinct populations in the species' ranges, to the lists. The viability ranking system used by the panelists is presented in Table 5-2. Hereafter, species considered throughout their range and species evaluated by the panels in a portion of their range will be referred to collectively as "species or ranges." (The numbers in these modified short lists are shown in Table 5-3.)

Table 5-2 Five-Class Viability Ranking Scale Used to Assess the Likelihood That Populations of Each Old-Growth Associated Species Would Stabilize or Increase Over Time. The Timeframe Considered Here is Approximately 50 Years (a Period Over Which we Assume that Most Old-Growth Forest Outside No-Yield Forest Allocations Would be Harvested).

HIGH - There is a high likelihood that the population(s) of the species would stabilize in National Forests within the range of the northern spotted owl. This provides broad latitude for natural catastrophes and uncertainties in knowledge. The likelihood of widespread or complete extirpation is low.
MEDIUM HIGH - There is a moderately high likelihood, somewhat better than 50/50, that the populations of the species would stabilize in National Forests within the range of the northern spotted owl. This provides limited latitude for natural catastrophes and uncertainties in knowledge. There is less than a 50/50 likelihood of widespread or complete extirpation.
MEDIUM - There is a roughly 50/50 likelihood that the population would stabilize, and a simflax likelihood of widespread or complete extirpation in National Forests within the range of the northern spotted owl. This provides extremely limited latitude for natural catastrophes and uncertainties in knowledge.
MEDIUM LOW - There is less than a 50/50 likelihood that the population would stabilize, and a greater than 50/50 likelihood of widespread or complete extirpation in National Forests within the range of the northern spotted owl. There is no latitude for natural catastrophes and uncertainties in knowledge.
LOW - It is highly unlikely that the species' populations would stabilize, and there is high likelihood of widespread or complete extirpation in National Forests within the range of the northern spotted owl. There is no latitude for natural catastrophes and uncertainties in knowledge.

Identification of Species With Viability at Risk - Three broad categories of species at risk of extirpation were defined by summarizing the viability rankings (shown in Table 5-2): low risk, medium risk, and high risk. We defined extirpation as the local extinction of a species from one or more National Forests within the range of the northern spotted owl, as a direct (but possibly delayed) effect of specific forest management activities. Thus, extirpation means the elimination of a species from a National Forest although it might continue to exist elsewhere. Exceptions to this may be local endemic species, such as stocks of anadromous salmonids, which are either entirely or largely restricted to areas managed by Forest Service.

For anadromous fish stocks, we used the risk of extinction ratings of Nehlsen et al. (1991). Stocks were identified as having a moderate or high risk of extinction or to be in need of special management considerations beyond those currently implemented in National Forest Land and Resource Management Plans. Criteria for these ratings were population size and trend.

Species with low risk of extirpation are those that were ranked by the panelists as "high" or "medium high" viability (Table 5-2) over an approximately 50-year period under at least one alternative. We felt that species in this category were likely to meet the population viability criteria presented in the regulations (36 CFR 219.19) implementing the National Forest Management Act; these species were not considered to be at risk.

Species with medium risk of extirpation are those that were generally ranked by the panelists as less than "medium high" viability (Table 5-2) over an approximately 50-year period under at least one alternative. We felt that such a risk category failed to meet the population viability criteria presented in the regulations implementing the National Forest Management Act.

A 50-year time period was chosen as representing a median duration over which adverse effects on viability as well as any significant modification of old-growth forest habitats, particularly timber harvesting, would occur.

Species with high risk of extirpation are those that were generally ranked by the panelists as less than "medium" viability (Table 5-2) over an approximately 50-year period under at least one alternative. High risk species are strictly a subset of the list of medium risk species above. High risk species are of even greater concern than are medium risk species because of their higher likelihood of extirpation within one or more planning area (National Forest) over the next years.

The panel of experts provided professional advice for use in our evaluation; the Scientific Analysis Team, however, made the final interpretations on viability. Overall, both levels of risks to viability were identified for all species groups except for invertebrates and fish stocks. Ecological associations and geographic distributions of invertebrates are very poorly known; therefore, viability of each invertebrate species could not be evaluated under each alternative at the present time.

Assessment of the probability of the proposed measures for maintaining and restoring habitat for anadromous salmonid fish stocks considered at risk (Nehlsen et al. 1991) was done for all 112 stocks as a unit rather than for individual stocks. Habitat degradation, which includes loss of or a decrease in the quality of freshwater habitat, has contributed to the decline of each stock (Nehlsen et al. 1991). Habitat requirements of the various species comprising the stocks vary considerably (Bjornn and Reiser 1991, Groot and Margolis 1991); however, and responses changes in habitat conditions resulting from land management activities may also vary (Reeves et al., in press). Although habitat requirements may vary, all species are dependent on the same suite of ecological processes and elements that structure and maintain habitat. We therefore assumed that the proposed mitigation actions were sufficiently robusto address the processes and elements that influence fish habitat and would result in the creation and maintenance of a range of conditions conducive to supporting all species and stocks collectively. Thus, we did not analyze each stock separately.

All aspects of the development of species lists were conducted in close coordination with the Northern Spotted Owl Recovery Team (USDI). Our assessments began with those conducted the Northern Spotted Owl Recovery Team, particularly by Anthony et al. (1992).

Viability Evaluation Methods- The following specific methods were used to evaluate viability of each species group.

a. Nonvascular Plants- An assessment of fungi, lichen, and nonvascular plants (bryophytes, including clubmosses, mosses, and liverworts) was led by Robin Lesher, a Forest Service botanist, under the guidance and oversight of the Scientific Analysis Team. (For purposes of clarity and brevity in this report, fungi, lichen, and bryophytes will be referred to collectively as nonvascular plants, although this is not strictly correct terminology.) Because much of the expert knowledge of these species resided with academic experts in the Pacific Northwest, contracting for and review by experts from outside the Forest Service was a major component of this assessment. These "outside" experts and

reviewers identified species closely associated with old-growth conditions and compiled known data on distribution and ecology of each species, Forest Service botanists also worked with the expert panel to evaluate potential risks to viability under each Final Environmental Impact Statement alternative and to identify mitigation options to help ensure high viability.

Collectively, fungi, lichen, and nonvascular plants were included in the assessment because they are vital elements of forest ecosystems. They play central roles in nutrient cycling and uptake by conifers and other tree species of commercial value, provide reservoirs of water, participate in decay and decomposition of organic matter and replenishment of soil fertility, and other ecological functions. Their ecological roles, distribution, abundance, and environmental relationships deserve greater study under ecosystem approaches to forest management.

As an example, some species of fungi (mychorrizae) are essential symbionts for assisting coniferous trees in nitrogen absorption. Their abundance, distribution, and sensitivity to changes in old-growth forest conditions directly influence forest health. Also, the ecology of dispersal agents for mychorrizae, such as northern flying squirrels, also play important roles in maintaining forest health. Lichens are used elsewhere as indicators of air quality. Likewise, many species of nonvascular plants are sensitive to changes in old-growth microclimates and habitat conditions and would likely serve as useful biological indicators of changes in forest ecosystem health.

b. Vascular Plants - Vascular plants were assessed with the help of a Forest Service core team of plant experts under the guidance and oversight of Joan Ziegltrum (a Forest Service ecologist) and the Scientific Analysis Team. Species lists and ecological characteristics of the species were compiled from existing literature, unpublished data from the Forest Service old-growth research program, ecology data bases from the Forest Service's Pacific Northwest and Pacific Southwest Regions, and information on threatened, endangered and sensitive plants from the Forest Service, Washington Natural Heritage Program, Oregon Natural Heritage Program, California Department of Fish and Game Natural Diversity Data Base, and California Native Plant Society (also see references cited in Appendix 5-B).

The core team of plant experts sought analysis and evaluation help from Forest Service botanists and ecologists, and from state and academic experts outside the Forest Service. The core team also worked with the expert panel on plants to evaluate potential risks to viability and to identify mitigation options.

c. Invertebrates - As a starting point in evaluating effects on invertebrates associated with old growth, we relied on earlier reports provided by the Northern Spotted Owl Recovery Team. The previous reports were authored by Frest and Johannes (1991) and Lattin and Moldenke (1992) and were used for the appendix on other species and ecosystems in the Draft Northern Spotted Owl Recovery Plan (see Anthony et al. 1992). These reports were reviewed under new contracts conducted for us as follows.

The report on mollusks by Frest and Johannes (1991) was reviewed by Ingrith Deyrup-Olsen, Professor Emeritus of Zoology at the University of Washington, Seattle, and an expert in the field (see Appendix 5-E for all reviewers' affiliations). The review

focused on evaluating the content and conclusions of the previous report (letter to Scientific Analysis Team from Deyrup-Olsen dated November 6, 1992).
The report on arthropods by Lattin and Moldenke (1992) was reviewed under contract with The Xerces Society in Portland, Oregon, a society established for the study and conservation of invertebrates. The contract resulted in a second report, authored by David M. Olson (1992), Division of Environmental Studies, University of California, Davis. Olson reviewed the content and conclusions of the previous work and included a qualitative evaluation of how the five Final Environmental Impact Statement alternatives collectively might affect arthropods.

Because of a lack of information, invertebrates were not evaluated for viability under each of the planning alternatives. However, the contract reports consistently underscored the following themes: (1) invertebrates are little studied and little understood in the Pacific Northwest; (2) many species play crucial and diverse ecological roles in late-successional forest ecosystems, including decomposers of organic material for replenishment of soils, pollinators of flowering plants, and prey for a wide variety of other invertebrates and vertebrates; and (3) many arthropods can serve as biological indicators of forest health (Lattin and Moldenke 1992, Asquith et al. 1990, Olson 1992).

d. Fish - Evaluation of the effects of the various alternatives on habitat of at-risk stocks of anadromous salmonids in National Forests within the range of the northern spotted owl was derived from ongoing evaluations of anadromous fish (USDA 1992a). The assessment for these stocks was based on habitat conditions and not populations. Refer to Appendix 5-K for justification for assessing the effects on habitat.

Each alternative in the Final Environmental Impact Statement was evaluated in terms of: (1) the probability of maintaining or restoring riparian zones and their ecological functions and processes; (2) presence and components of a watershed restoration program; and (3) the fraction of the landscape covered by spotted owl reserves, particularly that contained within key watersheds (Johnson et al. 1991). All Final Environmental Impact Statement alternatives lacked riparian management standards and a watershed restoration component. Therefore, we assumed that riparian zone management standards and guidelines for Land and Resource Management Plans would apply. Emphasis was on the fraction of key watersheds contained within spotted owl reserves.

Key watersheds had previously been identified as part of an evaluation of alternatives for the management of late-successional forests by Johnson et al. (1991). These were watersheds that either currently contained good quality habitat or were in poor condition but had a strong potential to be restored. These were identified with the assistance of fish biologists from National Forests within the range of the northern spotted owl. Key watersheds identified in Johnson et al. (1991) in California were modified slightly after evaluation by the Forest Service's Pacific Southwest Region Fish and Watershed Work Group, which did so as part of an assignment to develop a strategy for managing fish habitat and riparian ecosystems for the Six Rivers, Mendocino, Klamath, and Shasta-Trinity National Forests. Some watersheds originally identified were removed and others added. Key watersheds in California that were evaluated in this exercise included these changes.

e. Terrestrial Vertebrates - We evaluated amphibians, reptiles, birds, and mammals by review of selected literature on species' orientations to late-successional and old-growth forests to identify long and short lists. We also worked with the expert panels on amphibians and reptiles, birds, and mammals to evaluate potential viability concerns under each Final Environmental Impact Statement alternative and mitigation options to help ensure high viability.

We also sought technical advice on viability of, and mitigation options for, marbled murrelets from several experts on the species including Eric Cummins and Thomas Hamer (Washington Department of Wildlife), Kim Nelson (Oregon Cooperative Wildlife Research Unit, Oregon State University), and C. john Ralph (Pacific Southwest Forest and Range Experiment Station, Forest Service).

Identification of Unknowns and Species of Undetermined Status - For each species group above, we also identified the species for which scientific information is inadequate or lacking by which to judge viability effects and mitigation options needed to help ensure high viability over time.

Identification of Mitigation Options

The expert panels helped to identify mitigation options for habitat conditions conducive to providing for high viability, for all medium-risk species (that is, those species that ranked less than "medium high" in viability). Mitigation options included general quaiitativ_eand, where available, quantitative management standards that would provide needed habitat conditions, such as provision of components of old-growth forests outside Habitat Conservation Areas for northern spotted owls.

In identifying mitigation options (standards and guidelines for management of vital habitat components), we relied on the advice of the expert panels on plants and terrestrial vertebrates, the content of the contract reports on invertebrates, results of the Pacific Salmon Workgroup, and additional supplementary information on fish, northern goshawks, marbled murrelets, American marten, lynx, and other species.

To combine mitigation options among all medium-risk species under Alternative B, we used the following incremental process (hereafter referred to as steps, although they should be applied as a collective set and not necessarily in a step-wise fashion). In each step, the habitat needs of additional old-growth species were provided in a cumulative fashion. To ensure the needs of all species, the mitigation guidelines resulting from all steps would need to be adopted.

The general procedure we used to develop the mitigation steps follows. We first identified old growth protected by existing National Forest Land and Resource Management Plans. Next, we included the Interagency Scientific Committee's Conservation Strategy for the northern spotted owl in National Forests, as analyzed in the Final Environmental Impact Statement. One variant of the Interagency Scientific Committee's Conservation Strategy that we included here as an optional mitigation step is the modification to Habitat Conservation Areas as presented in Chapter 3 of this report. Next, we considered the additional needs for species with existing or impending Federal threatened or endangered species status; these were also additional old-growth species with the broadest scope of habitat requirements or distributional ranges, and with current viability concerns. These species included anadromous at-risk fish stocks and marbled murrelet. We then added other old-growth species of more local concern and with narrower ecological or

distributional ranges. Finally, we added any additional species that occur in the upland forest matrix that were not already included in the above lists. The overall result of implementing the mitigation activities identified in all steps combined is likely to be security from extirpation for all species of late-successional and old-growth forests in National Forests within the range of the northern spotted owl, for which scientific information was adequate. However, the degree of security from extirpation risk for species on which there was inadequate information is still unknown and cannot be judged.

Mitigation Step 1 - Standards and Guidelines From Existing Land and Resource Management Plans of National Forests Within the Range of the Northern Spotted Owl. This step entailed simply accepting the standards and guidelines in existing National Forest Land and Resource Management Plans. The viability needs of some of the "short list" species closely associated with old-growth forests or old-growth forest conditions would be provided by these standards and guidelines for forest management. This step entailed identifying which species would and would not be provided for under existing standards. We assumed for this assessment that existing management direction corresponded to Final Environmental Impact Statement Alternative A.

Mitigation Step 2a - Standards and Guidelines for Habitat Conservation. Areas Under Alternative B. We identified the standards and guidelines for habitat management under Alternative B (the Interagency Scientific Committee's Conservation Strategy) in the Final Environmental Impact Statement. This established the extent and locations of Habitat Conservation Areas and management guidelines for provision of dispersal habitat in the forest matrix between Habitat Conservation Areas, according to guidelines from the Interagency Scientific Committee's Conservation Strategy. In this step, we identified the species that would and would not be provided for by the combination of the standards and guidelines from National Forest Land and Resource Management Plans and from Alternative B of the Final Environmental Impact Statement.

Mitigation Step 2b - Recommended Additions to Habitat Conservation Areas in National Forests We identified additions to Habitat Conservation Areas within National Forests that may be needed as mitigation options for reduced spotted owl viability associated with preferred alternatives of Bureau of Land Management's Draft Resource Management Plans (see Chapter 3).

Mitigation Step 3 - Standards and Guidelines for Riparian Habitat Conservation Areas We then applied standards and guidelines designed for protecting habitat for the 112 fish stocks at risk. This step provided a substantial increase in the distribution and extent of existing and potential old-growth forest cover for a wide variety of species. We listed the resident fish and non-fish species likely to be also benefited by mitigation options for anadromous fish and riparian habitat.

Mitigation Step 4 - Standards and Guidelines for Marbled Murrelet We developed standards and guidelines for protecting nesting habitat for the marbled murrelet. This accounted for additional forest areas conserved within proximity to marine environments. We then identified other species likely benefited by the combination of guidelines for the Riparian Habitat Conservation Areas and for protection of nesting habitat for the marbled murrelet.

Mitigation Step 5 - Standards and Guidelines for Rare and Locally Endemic Species
We then identified rare and locally endemic species requiring inventory for locating specific occurrences, for the purpose of conserving habitat conditions at those individual sites.

Mitigation Step 6 - Additional Standards and Guidelines for Other Species in the Upland Forest Matrix. Finally, we identified any other species not included in the first five steps that would require additional standards and guidelines for conserving old-growth forests and components of old-growth forests in the upland forest matrix outside of conservation areas described in Mitigation Steps 1 through 5.

We did not quantitatively analyze the demography, population size and trend, genetics, or disturbance dynamics of populations and their environments, Rather, we addressed only the components of habitats directly or indirectly affected by management activities in National Forests. Managing such components is a necessary, but not always sufficient, set of conditions to ensure viability of each species throughout its range, even only in National Forests. For example, restoring viability to many fish stocks at risk would also entail addressing problems outside National Forests, including effects of hydroelectric structures, harvesting, and hatchery practices. Likewise, changes in regional climate and air quality would likely affect the distribution of species of lichen and other nonvascular plants in inland valley environments outside National Forests, thereby increasing, over time, the species' reliance on old-growth forest habitats in National Forests over time. These are significant factors to consider in a viability assessment. As new information becomes available, a reevaluation of our recommendations may well be warranted if future viability analyses incorporate these factors.

Also, management of late-successional forests and northern spotted owl habitat on other lands, such as those administered by the Bureau of Land Management in southwest Oregon, can influence the distribution and abundance of many old-growth wildlife species in National Forests. Overall, we did not quantify such potential off-site effects, but we did consider their qualitative influences on National Forest biota and accounted for them in many of our evaluations.

We also addressed the habitat requirements of some species whose geographic range overlaps that of the northern spotted owl only along fringes of their ranges. Some of these specie s were rated as having medium to high risk to viability. However, management of their habitats outside the range of the northern spotted owl would have a major influence on maintaining their long-term viability. This report does not address those additional needs because our charge was to identify extirpation risks and mitigation options for helping to ensure viability of species and habitats within the northern spotted owl's range.

We also identified mitigation options in coordination with Forest Service Pacific Northwest and Pacific Southwest Regions, drawing on management standards and guidelines in preparation but not yet in effect. This was particularly useful for identifying habitat needs of marbled murrelets, northern goshawks, and American martens, and for coordinating with ongoing management efforts to provide these needs.

RESULTS

Identification of Old-Growth Species

We evaluated over a thousand plant and animal species for their association with old-growth forests of the Pacific Northwest within the range of the northern spotted owl (this was the "long list" of species; see Appendix 5-A for long list of terrestrial vertebrates). These species included nearly 700 species of plants and fungi, 214 stocks of at-risk anadromous salmonids, 4 species of resident fish, and 224 terrestrial (non-fish) vertebrates (Figure 5-1). In addition, our contractors considered hundreds of invertebrate species. Of these totals, 312 plants, 149 invertebrates, 112 stocks of anadromous salmonids, 4 species of resident fish, and 90 terrestrial vertebrates were found to be closely associated with old-growth forest conditions ("short list" species). We had concerns for viability under each alternative in the Final Environmental Impact Statement for a smaller subset of species, as described below. We also had concerns about the viability of all 112 fish stocks identified for our project by our fish habitat experts, and all 149 species of invertebrates identified by our contractors and in the previous assessments.

Assessments by Species Groups

Nonvascular Plants - A total of 42 species of fungi (mostly mushrooms) and 148 species lichens and nonvascular plants (liverworts and mosses) were evaluated for viability status under each of the five alternatives in the Final Environmental Impact Statement (Appendix 5-It). Little is known about many of the fungi, lichen, and nonvascular plants. Scientific, ecological information was lacking for 39 species. As a result, viability could only be rated with great uncertainty, if at all (Appendix 5-J). However, viability assessments could be made for many other species for which more information was available. The number of species assigned medium risk to viability ranged from 19 under Alternative D to 147 under Alternative E. The number of species with a high risk to viability ranged from 4 under Alternatives B, C, and D, to 82 under Alternative E.

Under Alternative B - the selected alternative in the Final Environmental Impact Statement (the Interagency Scientific Committee’s Conservation Strategy) - 38 species or ranges were at medium risk (Appendix 5-H). The 38 species or ranges included 18 fungi, 2 lichens, 6 liverworts, and mosses. The 4 species with high risk to viability under Alternative B included 1 species of fungus and 3 mosses.

Vascular Plants - A total of 122 species or ranges of vascular plants were evaluated for viability effects (Appendix 5-H). Vascular plants include a wide variety of life forms, some of which are economically important to the Pacific Northwest. Species of vascular plants assessed in this report included saprophytes (plants that live off of decaying vegetable matter), root parasites, orchids, grape ferns, heaths, shrub heaths, coniferous trees, ferns, grasses, and other herbaceous forms. As with all other species groups evaluated in this report, some of the vascular plant species have quite narrow geographic distributions ("local endemics") or occur only in very specific conditions of forest structure and soil (such as the serpentine barren species of Klamath Mountains in southwestern Oregon and northwestern California).

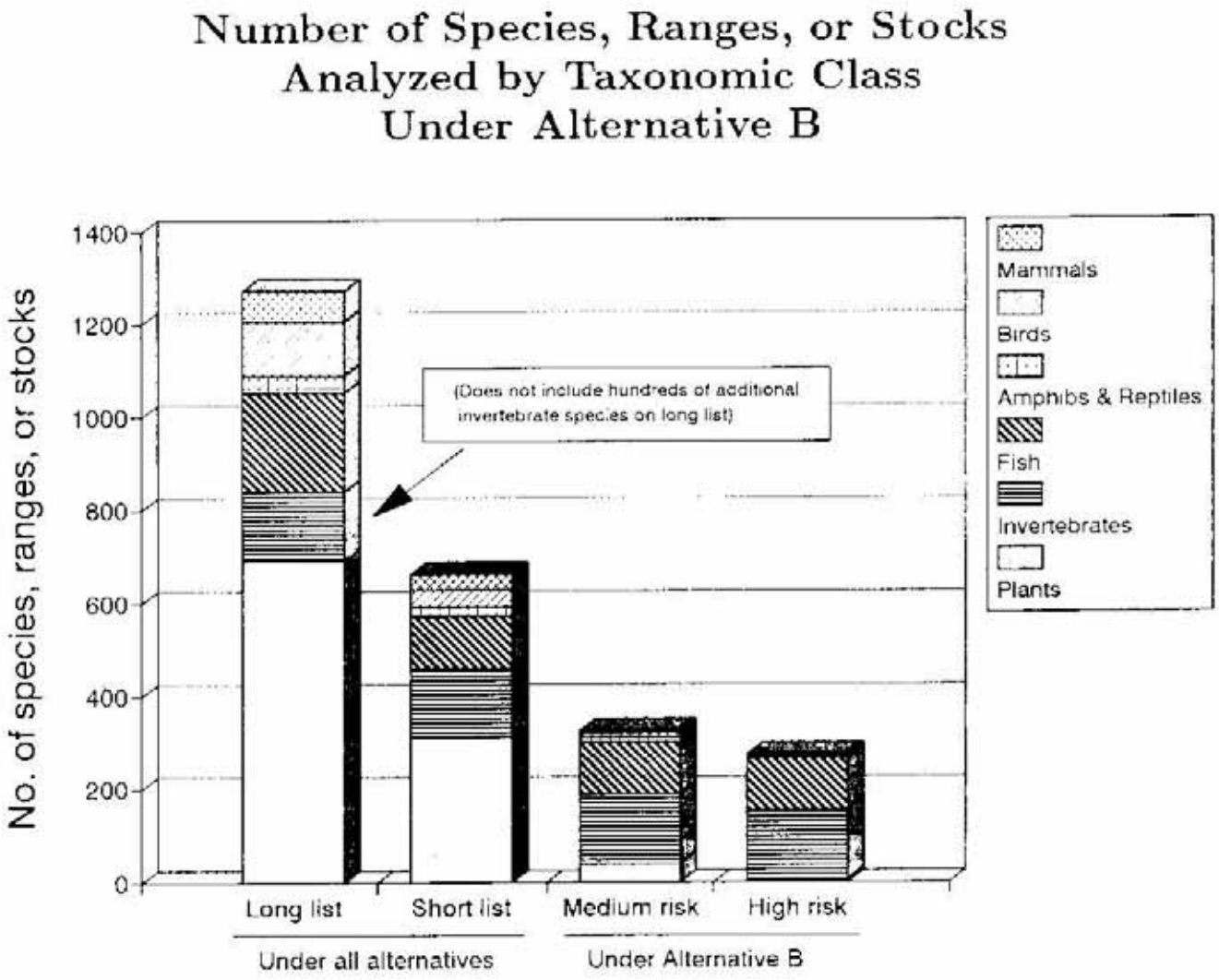


Figure 5-1 Number of Species, Ranges, or Stocks Analyzed by Taxonomic Class Under Alternative B of the Final Environmental Impact Statement.

Under each of the five alternatives described in the Final Environmental Impact Statement, the number of species or ranges with medium risk to viability ranged from none under Alternative B to 5 under Alternative E. One species, Pacific yew, is at high risk, but only under Alternative E. Sufficient scientific information to justify rating viability by alternative was lacking for 10 species.

Under Alternative B, none of the vascular plant species was determined to have either medium or high risk. However, two vascular plants (both are orchids) were rated as being at medium risk viability under Alternatives C and D. This is because the species require ground fire disturbance that the panel on vascular plants felt might be more rare and less extensive under Alternatives C and D than under Alternative B.

Invertebrates - A total of 149 species of invertebrates, including 58 mollusks and 91 arthropods (Appendix 5-F), were identified as closely associated with old-growth forests or old-growth forest conditions. Out of a regional list of more than 7,000 species (Olson 1992), we could find reliable data on distribution for only a few hundred species closely associated with old growth.

Olson (1992) concluded that none of the proposals for spotted owl conservation areas on Federal lands would be adequate to capture the full invertebrate diversity that currently exists across the landscape. In particular, in the coming century, if the only remaining tracts of old-growth forest are located within the Habitat Conservation Areas and Critical Habitat Areas designated in Alternatives B and C in the Final Environmental Impact Statement, "then there is a very high probability that many invertebrate species extinctions will occur in areas not covered by protected lands, particularly in the coastal forests of Oregon and northern California, the Klamath Province, and the Olympic Peninsula that are known for a high degree of [species] diversity" (Olson 1992:9-10). Although Olson may have underestimated the extensive coverage of Habitat Conservation Areas under Alternatives B and C in the Oregon Coast Range and Olympic Peninsula Provinces, local distributions of some invertebrate species might still range outside the Habitat Conservation Areas. Populations of the less vagile species remaining within Habitat Conservation Areas would likely become isolated into smaller populations unless connected with corridors of forest cover, as might be provided by some of the mitigation options discussed below.

We identified 79 invertebrate species as closely associated with both old-growth forests and riparian habitats (see Appendix 5-F). Many of these species would likely benefit from increased riparian habitat protection, as discussed below under Mitigation Step 3.

Fish - We evaluated 112 stocks of anadromous salmonids representing 7 species found in National Forests (Appendix 5-C). Numbers of stocks of fish are based on current knowledge, and are likely to change. These stocks have been identified by Nehlsen et al. (1991) as being risk of extirpation. Additionally, we considered 4 other fish species recognized by Williams et al. (1989) as being in various stages of population decline (Appendix 5-C). These 4 species included bull trout which are currently being considered by the Fish and Wildlife Service for threatened status. Like the anadromous salmonids, habitat loss and degradation have also contributed to the decline of these 4 species. Habitat loss and degradation are responsible, at least in part, for the decline in habitat and populations of each stock.

None of the five alternatives described in the Final Environmental Impact Statement provided a high probability of maintaining or restoring fish habitat for the 112 anadromous salmonid stocks (Appendix 5-G). The Final Environmental Impact Statement alternatives did not specify any

riparian management zone standards; nor were Habitat Conservation Areas delineated based

on riparian zones or watersheds. Standards and guidelines for protecting riparian management areas vary substantially in quality among National Forests. Most plans lack goals that establish a "vision" for management and use of anadromous fish resources. Few plans include objectives for anadromous fish management that are: time-specific, measurable, comprehensive, and established on a drainage or other biologically significant basis. In general, planning documents fail to address indirect and/or cumulative effects, or they address them only in a cursory manner. Rarely do plans provide documentation of a formal, standardized cumulative effects process that was applied on a drainage specific basis. Few plans specifically consider anadromous fish needs in delineating management areas. Overall, such standards and guidelines were rated as fair because of the relatively small width of forest buffers protected from cutting along fish bearing streams, generally <200 feet, the absence or small size of riparian management areas along intermittent streams, and the amount of activity allowed within riparian management areas.

Additionally, among the five alternatives evaluated in the Final Environmental Impact Statement, a relatively small fraction (generally <25 percent) of the key watersheds were contained within designated areas managed primarily for northern spotted owl habitat, although this fraction varied by Final Environmental Impact Statement alternative and physiographic province. This coincides with the Draft Recovery Plan for the Northern Spotted Owl (USDI 1992a) estimate that <20 percent of the approximately 12,000 miles of streams with fish stocks considered at risk were within their Designated Conservation Areas. We estimated that more than 50 percent of the area of key watersheds in National Forests overlapped the designated areas managed primarily for spotted owl habitat (i.e., Habitat Conservation Areas; all remaining nesting, roosting, and foraging habitat)under Alternative D. However, Alternative D rated only a medium probability of maintaining and restoring fish habitat because of the riparian management standards and guidelines and the absence of a watershed restoration program in the National Forests. Other alternatives in the Final Environmental Impact Statement rated lower than Alternative D because of the lower percentage of coincidence of key watersheds and other streams inside areas protected from timber harvest.

Amphibians - A total of 21 species or ranges of amphibians were evaluated for viability effects. Some of the salamander species are locally endemic within small geographic ranges in the Pacific Northwest. The number of amphibian species or ranges judged to be at medium risk to viability ranged from 8 under Alternative D to 20 under Alternatives A and E. Of these, the number judged to be at high risk ranged from 6 under Alternative D to 18 under Alternative E. Scientific information was judged sufficient to assess viability effects of all amphibian species.

Under Alternative B, 11 species or ranges (including 10 salamanders and the tailed frog) were determined to be at medium risk and 7 at high risk. Van Dyke’s salamander was considered in two parts of its overall range, and was rated as being at high risk of extirpation in both parts, under Alternative B. Most of the 11 at-risk species or ranges have narrow geographic distributions and occur in localized riparian, headwater, or talus (loose rock) habitats.

Reptiles - A total of 10 species of reptiles (turtles, lizards, and snakes) were initially evaluated in the "long list" for their association with old growth (Appendix 5-A). None of these species was considered to be closely associated with old-growth forest conditions (Appendix 5-A). Thus, no further viability assessments were conducted on reptiles. However, some reptile species, such as the sharp-tailed snake and northern alligator lizard, are associated with components of old-growth forests, including large down logs and forest litter cover. Such species would be secondarily benefited by provision of such forest elements under any of the planning alternatives

and provision for riparian habitat protection.

Birds - A total of 38 species or ranges of birds were evaluated for viability effects. The birds included various species of owls and other birds of prey, marbled murrelet, song birds, and others.

Under each of the five alternatives described in the Final Environmental impact Statement, the number of species determined to be at medium risk to viability ranged from 6 under Alternative D to 17 under Alternatives A and E. Of these, the number of species determined to be at high risk ranged from 1 under Alternatives B, C, and D, to 6 under Alternative E. Information was sufficient to allow us to assess viability for all bird species.

Under Alternative B of the Final Environmental Impact Statement, 9 species were rated as being at medium risk and 1 of these species, marbled murrelet, at high risk. The species at medium risk included several species at the edge of their ranges (such as black-backed woodpecker and pygmy nuthatch) or that use riparian and aquatic habitats (such as bufflehead and harlequin duck). Other birds at medium risk that were distributed more broadly within the range of the northern spotted owl and more associated with spotted owl habitat included the northern goshawk, flammulated owl, and great gray owl.

Mammals - A total of 35 species or ranges of mammals were evaluated for their viability. These species included furbearers (including fisher, American marten, lynx, and others), bats, rodents, and other species groups.

Under each of the five alternatives described in the Final Environmental Impact Statement, the number of species or ranges judged to have medium risk to their viability ranged from 6 under Alternative D to 12 under Alternatives A and E. Of these, the number of species or ranges judged to be at high risk ranged from 1 under Alternative D, to 9 under Alternative E. Information was inadequate for ranking viability for 10 other species.

Under Alternative B of the Final Environmental Impact Statement, 8 species or ranges were rated as being at medium risk to viability and 5 of these as being at high risk. The American marten was ranked as being at medium risk in one portion of its range and at high risk in two other portions. The fisher was determined to be at medium risk in one portion of its range and at high risk in another portion. Both species of red tree vole (prey species of the northern spotted owl) rated as being at high risk. The ranges of the lynx and the northern spotted owl are both extensive but only overlap along a narrow fringe area. The lynx was rated as being at medium risk. Most of the bats could not be rated because of lack of information.

Summary of Species at Medium and High Risk - Appendix 5-H presents an overall list of species of all taxonomic classes judged to be at medium or high risk to viability under at least one of the five alternatives described in the Final Environmental Impact Statement. The number of species or ranges (excluding invertebrates and fish) determined to have medium risk to their viability totaled as low as 41 under Alternative D in the Final Environmental Impact Statement and as high as 201 under Alternative E in the Final Environmental impact Statement. Alternative E in the Final Environmental Impact Statement had the greatest number of species or ranges estimated to have medium risk, in part because it does not provide for old growth in Habitat Conservation Areas for the spotted owl in the Olympic Peninsula or in the northern Oregon Coast Range. Alternative E also provides for substantially less amounts of old growth protected in other locations in the Pacific Northwest. Alternative A in the Final Environmental Impact Statement also had high numbers of species or ranges determined to have

risks to viability because its reserves for spotted owls (Spotted Owl Habitat Areas) provided for

substantially smaller old-forest conservation areas than do Alternatives B, C, and D in the Final Environmental Impact Statement. Alternatives B, C, and D in the Final Environmental Impact Statement progressively provide for greater numbers of species or ranges. Under Alternative B in the Final Environmental Impact Statement, 67 total species or ranges (excluding invertebrates and fish) were ranked medium risk and 17 of these were ranked high risk. With inclusion of invertebrates and fish, these tallies were 328 and 278, respectively.

The 32 Old-Growth Species Listed in the Final Environmental Impact Statement

Thirty-two species associated with late-successional forests were listed in the Final Environmental Impact Statement. All 32 were included in the short list of species closely associated with old growth. Under Alternative B of the Final Environmental Impact Statement, 25 of the 32 species were not considered to be at risk in terms of viability. Three species are at medium risk to viability, and 3species were Considered at high risk. In addition, the Scientific Analysis Team considered one species from the list of 32 species - the Olympic Salamander" as a (newly defined) complex of four species,¯ one of which was deemed to be at medium risk and three of which were deemed to be at high risk. Another species - red tree vole - is considered here as a (newly defined) complex of two species, both of which were deemed to be at high risk extirpation. And one species, fisher, was considered to beat medium risk in one portion of its range and at high risk in the other (Appendix 5-I).

Mitigation Options for Species With Medium or High Risk to Viability Under Alternative B

Mitigation options were considered for the set of 328 species or ranges (38 fungi and nonvascular plants, 0 vascular plants, 58 mollusks, 91 arthropods, 112 fish stocks, 12 amphibians, 0 reptiles, 9 birds, and 8 mammals; see Table 5-3) considered to be at medium or high risk to viability under Alternative B of the Final Environmental Impact Statement (also see below for lists of species accommodated under each step in the mitigation process). Mitigation options developed for the 112 stocks of anadromous salmonids also provide protection to viability for the 4 additional species of resident fish.

We assumed that habitat conditions for species closely associated with old growth would be maintained under the following mitigation options. If the protected areas called for are manipulated in a way that diminishes old-growth habitat conditions, our assumption would no longer be valid.

The step-down mitigation procedure resulted in identifying the following sets of species requiring management standards and guidelines beyond those in Alternative B as described in the Final Environmental Impact Statement. These steps are cumulative in effect. Each set of species considered in a step assumes implementation of mitigation activities in all previous steps.

Mitigation Step 1 – <u>Standards and. Guidelines From Existing Land and Resource Management Plans of National Forests Within the Range of the Northern Spotted Owl</u>. Standards and guidelines influencing the management of old-growth forests and components of :old-growth forests are described in the individual Land and Resource Management Plans for National Forests within the range of the northern spotted owl They are not repeated here. Species associated with old-growth forests or old-growth forest components within

the range of the northern spotted owl that would be provided for by application of the Land and Resource Management Plan standards and guidelines include all of the "short list" old-growth associated species that were not identified as being either at medium or high risk under Alternative A (current management direction). (Complete lists of species evaluated are available from the authors upon request.)

Mitigation Step 2a - Standards and Guidelines for Habitat Management Under Alternative B. This step entailed reviewing the standards and guidelines for management of habitat for northern spotted owls under the selected alternative (Alternative B) the Final Environmental Impact Statement. Habitat needs for the northern spotted owl are provided by this alternative, assuming that the Interagency Scientific Committee's guidelines are followed on all Federal lands. In addition, other old-growth species provided for by application of Alternative B of the Final Environmental Impact Statement that are not included in the first mitigation step above, are those species that were identified as being either at medium or high risk under Alternative A (current condition) but not under Alternative B. Implementation of Alternative B would reduce the number of species with risk of extirpation by 120 species (Table 5-3).

Mitigation Step 2b - Recommended Additions to Habitat Conservation Areas in National Forests This optional step entailed reviewing the additions to the Habitat Conservation Areas in National Forests if necessary under the assumption that USDI Bureau of Land Management would not follow the Interagency Scientific Committee's Strategy (Chapter 3). Without adjustment of Habitat Conservation Areas in National Forests, viability of the northern spotted owl is rated as low under their current plans (the "Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement Areas"), and medium under preferred alternatives in the Bureau of Land Management's Draft Resource Management Plans. With the addition of approximately 418,000 acres to Habitat Conservation Areas in National Forests, the spotted owl's viability would be rated as high (Chapter 3). The addition to Habitat Conservation Areas of 418,000 acres would contribute to maintaining the viability of a number of additional species. However, these additional acres were not designed to provide mitigation for species other than the spotted owl. In addition, the designation of these acres was only one of several outcomes, depending on the plan actually adopted by the Bureau of Land Management. For this reason, we did not tie the viability assessment of any other species to this acreage.

Table 5-3 Number of Species or Ranges and Fish Stocks Identified as Potential Viability Concerns That are Protected by the Cumulative Mitigation Steps Discussed in the Text.

Mitigation Step:	1. National Forest planning standards and guidelines	2a. or 2b.[1] Alternative B FEIS[2] standards and guidelines	3. Species benefited by Riparian Habitat Conservation Areas	4. Species benefited by marbled murrelet protection	5. Mitigation for rare and locally endemic species	6. Additional mitigation for upland forest matrix species	TOTAL (All 6 mitigation steps)	Unknowns	
Species groups								Unknown but likely protected by mitigation measures	Degree of protection generally unknown
Nonvascular Plants (198)[5]	18	95	5	19	14	0	151	20	19
Vascular Plants (122)	108	4	0	0	0	0	112	2	8
Invertebrates (149)		(Not rated by alternative)						0	149
Fish[3] (112)	0	0	112	0	0	0	112	0	0
Amphibians (21)	1	8	7	1	3	1	21	0	0
Reptiles[4] (0)	0	0	0	0	0	0	0	0	0
Birds (38)	20	9	2	2	0	5	38	0	0
Mammals (35)	13	4	5	2	0	1	25	1	9
TOTAL (667)	160	120	131	24	17	7	459	23	185
Cumulative Guidelines that apply	1	1-2	1-3	1-4	1-5	1-6	1-6	1-6	1-6
Cumulative spp. totals	160	280	411	435	452	459	459	482	667

[1]This column reflects either the original standards and guidelines in Alternative B of the Final Environmental Impact Statement or those standards and guideline supplemented by mitigations for actions on lands administered by the Bureau of Land Management (see Chapter 3).
[2]FEIS = Final Environmental Impact Statement.
[3]Mitigations developed for 112 stocks of anadromous salmonids also provide for 4 additional species of resident fish.
[4]No reptile species was identified on the short list of species closely associated with old-growth forests, and thus none was identified as extirpation risk.
[5]Values in parentheses axe the total number of species or ranges and fish stocks identified by each expert panel as closely associated with old-growth forests or conditions ("short list" species) in National Forests within the range of the northern spotted owl.

Mitigation Step 3 - Standards and Guidelines for Riparian Habitat Conservation Areas

a. Riparian Habitat Conservation Area Designation

The size and management of Riparian Habitat Conservation Areas vary depending on stream type and aquatic ecosystem type as outlined in Table 5-4. Riparian Habitat Conservation Area widths for streams are horizontal distances and are measured on each side from the edge of the active stream channel. Active channels consist of all portions of the stream channel carrying water at bankfull flows. They include side-channels and backwaters, which may not carry water during seasonal low flows. Riparian Habitat Conservation Area dimensions for lakes, ponds, springs, seeps, meadows, and small wetlands are measured from the outer edge of the seasonally saturated soils. In the case of reservoirs, distances are measured from the maximum pool elevation. See Appendix 5-K for further criteria on establishing Riparian Habitat Conservation Area dimensions.

Table 5-4 lists interim minimum Riparian Habitat Conservation Area widths that will be in place until a watershed analysis is completed (as explained in Appendix 5-K). In general, watershed analysis consists of a systematic examination of Riparian Habitat Conservation Areas to characterize watershed history, processes, and landforms and conditions. Boundaries of Riparian Habitat Conservation Areas may be altered after completion of the watershed analysis if warranted by the information resulting from that analysis. The result is the identification of parts of the landscape that influence the creation and maintenance of habitat for fish and other riparian species. Particular attention should be given to terrestrial or semi-aquatic organisms (e.g., molluscs, amphibians) that are associated with the microclimates of non-fish bearing and intermittent streams. Habitat associations of many of these organisms are not completely understood at this time.

Table 5-4 Interim Boundaries of Riparian Habitat Conservation Areas (RHCAs) Delineated Along Different Water Bodies and Area of the Watershed.

Water Bodies	Interim Boundaries of RHCAs
Fish bearing streams	edge of active channel to: - top of inner gorge, or -outer edges of 100-year floodplain, or - outer edges of riparian vegetation , or - a distance equal to height of two site potential trees on each side of stream, or - 300 feet horizontal distance on each side of stream, whichever is greatest
Perennial, non-fish: bearing streams	edge of active channel to - top of inner gorge, or - outer edges of 100-year floodplain, or - outer edges of riparian vegetation, or - a distance equal to height of one site potential tree on each side of stream, or - 150 feet horizontal distance on each side of stream, whichever is greatest
Ponds, reservoirs, and wetlands >1 acre	edge of water body to: - outer edge of riparian vegetation, or - extent of seasonally saturated soil, or - extent of moderately or highly unstable areas, or - a distance equal to height of one site potential tree, or - 150 feet horizontal distance for ponds and wetlands >1 acre, - 150 feet from edge of maximum pool elevation of reservoirs ; whichever is greatest
Lakes	edge of water body to: - outer edge of riparian vegetation, or - extent of seasonally saturated soil, or - extent of moderately or highly unstable areas, or - a distance equal to height of two site potential trees, or - 300 feet horizontal distance, whichever is greatest
Seasonally flowing or intermittent streams, wetlands <1 acre, landslides and landslide prone areas	edge of stream channel or wetland to: - top of inner gorge, or - outer edges of riparian vegetation, or - extent of landslides and landslide-prone area5, or - a distance equal to height of one site potential tree on each side of stream, or - 100 feet horizontal distance on each side of stream, whichever is greatest

Within the Riparian Habitat Conservation Areas, timber management and other land management activities are essentially prohibited unless the watershed analysis indicates such activity is necessary to accelerate meeting desired ecological conditions. Specific standards and guidelines (Appendix 5-K) were developed to guide land management activities within Riparian Habitat Conservation Areas.

b. Other Species Benefited by Riparian Habitat Conservation Areas

The following species whose viability is considered to be at risk under Alternative B are likely to have their viability assured after application of the mitigation options for riparian habitat protection,

(1) Nonvascular plants:

(a) *Usnea longissima* (Lichen) This species is found in both hardwoods and softwoods in riparian fog belts. This species requires forests on broad riparian areas and should be maintained by protecting riparian habitats, especially by controlling upstream timber harvesting. These needs are likely met by the Riparian Habitat Conservation Area guidelines.

(b) *Metzgeria conjugata* (Liverwort) This species occurs in fog areas of coastal forests especially along streams. Its needs are likely met by the Riparian Habitat Conservation Area guidelines.

(c) *Dicranella palustra* (Moss) This species occurs in 1st-order streams coniferous forest and is sensitive to siltation. This species is endemic to the west coast and needs riparian forests. Mitigation options include protection of stream buffers of at least 100 feet width on each side of the stream, protection of non-anadromous streams, and upstream protection from logging and road building. Mitigation options also include preventing 1st-order streams from siltation and piling of logging debris, and maintaining a component of coarse woody debris for substrate needs. All of these mitigation activities are included in the Riparian Habitat Conservation Area guidelines.

(d) *Hygrohypnum bestii* (Moss) This species is included in the species group with *Dicranella palustva*, above, with the same conditions and mitigation options.

(e) *Mythicomyces corneipes* (Fungus) This mushroom occurs in low elevation moist humus soils with mosses and old-growth conifer stands throughout the range of the northern spotted owl from sea level to 4,000 feet elevation. Mitigation measures include maintaining moist conifer forest habitats. These needs are likely met by the Riparian Habitat Conservation Area guidelines.

(2) Amphibians:

(a) Van Dyke's Salamander (Coastal, Olympic Peninsula, and Cascades populations) - This species is associated primarily with seeps and streamside talus, although it also occurs in association with moist soil on shaded north-facing slopes. Van Dyke's salamander is very rare and occurs in

small, isolated populations. Seeps and headwater streams are key habitats throughout the species' range. The combination of National Forest Land and Resource Management Plans, Alternative B of the Final Environmental Impact Statement, and Riparian Habitat Conservation Area guidelines, particularly buffered habitats along headwater streams, will provide needed protection for this species. We foresee no critical needs for further protection.

(b) Olympic Salamander complex –

Olympic torrent salamander (Rhyacotriton olympicus) Olympic Peninsula
Columbia torrent salamander (R. *kezeri*) - Coastal Oregon (northern)and Washington (southern)
Cascade torrent salamander (R. *cascadae*) - Cascades of Oregon and Washington
Southern torrent salamander (R. *variegatus*)- Coastal Oregon (southern) and California (northern)

All species in this complex (formerly Olympic Salamander, Rhyacotriton olympicus) occur in association with Small, cold (46^{o} to 54° F in summer) streams, especially in mossy gravel or splash zones of rocky, tumbling brooks. They are sensitive to increased temperature and sedimentation. Therefore, the primary mitigation measure for this group is protection of small streams, including headwaters, through buffers on each side of designated sites.

(c) Tailed Frog - Tailed frogs, like Olympic salamanders, occur in small, cold streams and are very sensitive to temperature. The primary mitigation measure for this species is protection of headwater streams through buffers designated on each side of the streams. Buffers provided under the Riparian Habitat Conservation Areas guidelines will maintain cool temperatures and will reduce sedimentation. Such buffers should provide adequate mitigation for this species.

(3) Birds:

(a) Bufflehead - Buffleheads nest in tree cavities in riparian zones at low elevation. They are associated with ponds, lakes, streams, and rivers. Protection of forest cover along streams, as in the Riparian Habitat Conservation Areas, will likely lead to long-term maintenance of nesting and foraging habitat.

(b) Harlequin Duck - Harlequin ducks are primarily associated with high elevation mountain streams. They are sensitive to human disturbance and water quality. Riparian Habitat Conservation Areas, in conjunction with large areas protected in congressionally designated Wilderness and Habitat Conservation Areas, will likely provide high quality water and undisturbed nesting sites. Road closures may be important in some locations to reduce disturbance; in such cases, road closure plans must be developed and implemented as part of the watershed analysis for the Riparian Habitat Conservation Areas (see Appendix 5-K).

(c) Northern Goshawk - Riparian Habitat Conservation areas will benefit goshawks, but will not fully provide for viability. Benefits from Riparian Habitat Conservation Areas will be most significant on the Olympic Peninsula and the Cascades of Oregon and Washington. Additional measures for goshawks are discussed below, and full mitigation measures are discussed in Mitigation Step 4. We recommend completion and implementation of the Forest Service's Pacific Northwest Region management direction and inventory protocol for northern goshawk currently in preparation (USDA 1992b). The purpose of the direction is to protect known active nest sites until the Forest Service, working with other agencies, can determine the species' actual habitat requirements (letter dated October 1, 1992, from Forest Service, Pacific Northwest Regional Directors of Fish, Wildlife, and Botany, and Timber Management, to Forest Supervisors).

(4) Mammals:

(a) American Marten (Oregon Cascades) - American martens use riparian areas for foraging and for selection of resting sites in large standing trees or in piles of woody debris. Riparian buffers will protect potential habitat in riparian zones and will contribute to long-term provision of snags and logs. In conjunction with Alternative B, riparian habitat protection will be particularly important in the Coast Range and Cascades of Oregon. Mitigation options for American marten in other parts of its range in the Pacific Northwest is further discussed under Mitigation Steps 4 and 6, below.

(b) Fisher (populations in California and southern Oregon, and northern Oregon and Washington) - Fishers use a wider range of habitats than those used by American martens and are able to forage in early-successional forest with dense overhead cover, as in brushy cutover or burned forest. However, they are sensitive to forest fragmentation when patches of forest are isolated by extensive open areas. Large snags (:*20 inches dbh) are important as maternal den sites. The Riparian Habitat Conservation Areas will likely provide cover and large snags in the forest matrix between Habitat Conservation Areas and will thus substantially enhance the distribution of fisher habitat. Other considerations for mitigation options for fisher are discussed under Mitigation Step 6, below.

(c) Red Tree Voles (*Arborimus longicaudus and A. pomo*) - Distributions of both species of red tree vole are poorly known. Studies are needed to better understand their relative abundance in different forest types and to delineate their geographic distribution, although such studies are not essential components of this mitigation step. Both species of red tree vole are thought to have very limited dispersal capability. Thus, fragmentation of forest canopy habitat in the forest matrix (outside old-growth protection areas such as Habitat Conservation Areas) could be a concern under Alternative B, especially in the Oregon Coast Range. However, buffers along steams in the Riparian Habitat Conservation Areas should alleviate much of this potential concern by providing connectivity between many of the Habitat Conservation Areas and other reserves. Maintenance of forest corridors of stands averaging

at least 11 inches dbh and at least 40 percent canopy closure as required by the 50-11-40standard for spotted owl dispersal habitat in the Final Environmental Impact Statement Alternative B, between Riparian Habitat Conservation Areas and across ridgetops, may further facilitate dispersal between watersheds. Although forest stands averaging 11 inches dbh and 40 percent canopy closure likely do not provide optimal breeding habitat, we believe that such stands would provide at least some dispersal habitat linking watersheds.

Mitigation Step 4 -Standards and Guidelines for Marbled Murrelet

a. Standards and Guidelines for Marbled Murrelet.

The marbled murrelet is listed by the Fish and Wildlife Service as a threatened species. These proposed standards and guidelines for management of marbled murrelets and their habitat are intended to be interim in nature and are based on the Scientific Analysis Team's professional judgment, which in turn was based on consultation with experts on the species and the very limited published information available.

We anticipate that ongoing planting efforts for conservation of the marbled murrelet (such as those in preparation by the Fish and Wildlife Service's Recovery Team, and the Forest Service's Marbled Murrelet Conservation Assessment Team) will produce management plans for marbled murrelets and their habitat that will supersede these interim standards. Our intent is to preserve options for management of marbled murrelet habitat until these plans are in place.

(1) Habitat:

(a) Identify all suitable habitat, regardless of occupancy by marbled murrelets, within 35 miles of marine environments in California and Oregon south of State Highway 42 and within 50 miles of a marine environment in the remainder of Oregon and Washington, This zone represents a geographical area influenced by marine air masses and likely encompasses nearly all, if not all, of the suitable marbled murrelet habitat. Nesting habitat, used here interchangeably with the term suitable habitat, is of primary concern and is defined as old-growth conifer forest stands, or mature forest stands with individual trees ~32 inches dbh. Stand size is not an issue in this definition; stand size criteria should not be used to eliminate stands from consideration. The definition for suitable habitat is broad and for some National Forests habitat remains unmapped. It is, therefore, essential to complete the following tasks:

- The above definition of suitable habitat must be refined for each National Forest within the range of the marbled murrelet in cooperation with the U.S. Fish and Wildlife Service and the respective state wildlife agencies as necessary to fit specific habitat types used by murrelets across the range of the species.

- Each National Forest within the range of the marbled murrelet shall map suitable marbled murrelet habitat on that Forest.

(b) Stop all ongoing projects under contracts or other legally binding agreements that may affect suitable murrelet habitat. This cessation of activity shall continue until completion of consultation between the Forest Service and the Fish and Wildlife Service on proposed projects that may affect this species, as required under Section 7 of the Endangered Species Act. Projects shall then be modified as indicated by that consultation. Such consultation may result in cancellation of some projects.

(c) In the case of all other other ongoing or proposed projects or activities without contracts or other legally binding agreements, do not remove or modify the tree canopy in suitable habitat. Ongoing or proposed activities may proceed when a conservation strategy or recovery plan is implemented, and provided that the activities are consistent with the conservation strategy or recovery plan.

(d) Identify and delineate habitat recruitment stands (younger forest stands deemed likely to develop into suitable murrelet habitat) within 35 miles of the coast in California and Oregon south of State Highway 42 and within 50 miles of a marine environment in the remainder of Oregon and Washington. No timber cutting shall take place in such habitat recruitment stands so long as these interim standards and guidelines are in effect.

There appears to be consensus among experts on the marbled murrelet that protection of all currently suitable marbled murrelet habitat alone would be insufficient as a long-term management strategy. A conservation strategy for marbled murrelet that does not provide for recruitment of nesting habitat will not ensure that nesting habitat and conditions conducive for successful reproduction (those habitat components that are in National Forests and contribute to viability) will be provided.

It seems logical to assume that nesting habitat may limit marbled murrelet populations. Therefore, it is prudent for the interim to ensure that forest stands that will develop into nesting habitat are retained in sufficient amounts and appropriate locations. The exact amount of recruitment habitat necessary for a long-term conservation strategy or recovery plan is not known, so precise standards for selection of replacement habitat are not now available. Although new insights from ongoing studies and planning team efforts will likely result in modification, we believe that the following standards and guidelines, if adopted, will ensure that adequate amounts of forest stands which are available to develop into nesting habitat are protected until a recovery plan is adopted.

The intent of the standards and guidelines for delineating stands as recruitment habitat is to prevent further fragmentation of forests adjacent to present nesting habitat for marbled murrelets, buffer suitable habitat from edge effects, and preserve options to allow such stands to grow into nesting habitat. We concluded that it is neither possible nor prudent, given the present state of knowledge, to provide standards and guidelines that address site specific variation in arrangements and quality of younger stands. We expect there will be places on the landscape where the standards and

guidelines for delineating recruitment habitat cannot be applied exactly as outlined; Where that situation exists, we expect that selection of recruitment habitat will be made in a manner that best meets the intent of the guidelines as stated above. Selection of all recruitment habitat shall be made with interagency participation and cooperation.

Identification and Definition of Habitat Recruitment Stands:

1. Amounts of habitat recruitment stands equivalent to 50 percent of the total amount of existing suitable habitat outside Category 1 and 2 Habitat Conservation Areas (as described in the Interagency Scientific Committee's Conservation Strategy) and congressionally designated Wilderness will be delineated outside Category 1 and 2 Habitat Conservation Areas and such Wilderness. For example, if in a National Forest 60,000 acres of the existing suitable habitat for marbled murrelets occur outside Wilderness and Category 1 and 2 Habitat Conservation Areas, then 30,000 acres of habitat recruitment stands will be delineated outside Category 1 and 2 Habitat Conservation Areas and Wilderness. All younger forest stands inside Category 1 and 2 Habitat Conservation Areas and Wilderness within the range of the marbled murrelet are already protected and have the potential to develop into nesting habitat. Habitat recruitment stands should be as contiguous as possible and (where the stands exist)100 acres or more in size. Recruitment stands should be well distributed and adjacent to many nesting stands rather than concentrated around a few stands.

2. First priority for delineation of habitat recruitment stands shall be given to stands adjacent to suitable habitat with known occupancy by marbled murrelets.

3. After first considering the priority for delineation of habitat recruitment stands adjacent to occupied sites, priority for selection of habitat recruitment stands shall be given to those watersheds where an analysis indicates that suitable habitat for marbled murrelets comprises less than 30 percent of the watershed. The Fish and Wildlife Service in the Status Review for marbled murrelets indicated that marbled murrelets were found more often when the percent of old, growth/mature forests makes up over 30 percent of the landscape (I4amer and Cummins 1992). Our objective here is to preserve options for planning teams to incorporate key stands into a recovery plan or conservation strategy that will likely improve the future quantity, distribution, and quality of nesting habitat for marbled murrelets.

4. Priority for selection of habitat recruitment stands among various-aged stands shall be given to old-growth or mature coniferous stands that will likely develop murrelet habitat characteristics in the shortest time period. If such stands are not available in an area where marbled murrelet occupancy has been determined, the next oldest and/or largest stands shall be selected. Stands where the average dbh is smaller than 16 inches shall not be selected as recruitment stands.

5. Habitat recruitment stands should be selected considering their potential for buffering adjacent suitable habitat. This is especially significant where such stands are adjacent to occupied sites. In such cases recruitment stands should be selected to minimize danger of windthrow and edge effects to the existing nesting habitat.

6. For stands of suitable habitat known to be occupied by marbled murrelets and for which it is not possible to delineate recruitment habitat that buffers the stand, either because stands meeting the above standards for recruitment habitat did not exist or acreage amounts for delineation (that is, the 50 percent guideline discussed in paragraph 1 above) have been met, it will be necessary to delineate additional buffers. Such buffers shall consist of stands where the average dbh is at least 10 inches. For occupied stands of suitable habitat greater than 100 acres in size, the buffer should be at least 300 feet wide. Where the occupied stands of suitable habitat is less than 100 acres, the buffer shall be at least 600 feet wide. Inasmuch as possible, buffers should completely surround the suitable habitat. Modification of the buffers shall be avoided until a recovery plan or a conservation strategy for marbled murrelets is implemented.

(2) Surveys:

(a) Within suitable habitat and within 35 miles of the coast in California and Oregon south of State Highway 42 and within 50 miles of a marine environment in the rest of Oregon and in Washington, all surveys conducted for marbled murrelets shall follow current protocol for intensive surveys adopted by the Pacific Seabird Group (Ralph and Nelson 1992). Under that protocol a minimum of two years of survey should be conducted to confirm absence of marbled murrelets. Protocols should be reviewed and updated annually by an interagency body.

(b) Conduct transect surveys in California and Oregon, south of State Highway 42, beyond 35 miles from marine environments. This area is included in the descriptions of the range of marbled murrelets but is an area where marbled murrelet sightings have not been documented. There was disagreement between experts contacted as to whether marbled murrelets occur within this area. Transect surveys should be conducted in forest stands with the same structural attributes as those stands that meet the definition of suitable marbled murrelet habitat closer to marine environments. These transect surveys are needed to ascertain the actual range and distribution of marbled murrelet habitat. If marbled murrelets are detected beyond 35 miles from the coast in southern Oregon and northern California, the intensive surveys following the current protocol as described in paragraph 1 above shall be conducted. This would expand the area over which intensive surveys are to be conducted. If murrelets are not detected it may be appropriate to redefine the range,

(3) Seasonal Restrictions:

Activities that may not affect suitable habitat but have the potential to disturb nesting activity of marbled murrelets should be implemented based on the following:

(a) Management activities within a 1/4-mile radius of known occupied sites should be restricted from April 1 to September 15 if, after a review of the specific activity and the landscape by a qualified wildlife biologist, the activity is determined to have the potential to disturb marbled murrelet nesting activity. Potentially-disturbing activities include, but are not limited to, activities resulting from issuance of permits for road rights-of-way, felling in forest stands not suitable for nesting by marbled murrelets, road construction or reconstruction, blasting, yarding, operation of heavy equipment, and mining operations.

(b) Within the zone 35 miles from marine environments in California and Oregon, south of Oregon State Highway 42, and within 50 miles of marine environments in the rest of Oregon and Washington, restrict potentially disturbing management activities (as described above) within 1/4 mile suitable habitat unless absence of marbled murrelets has been determined through protocol surveys.

(4) Adaptive Management:

(a) These guidelines should be reviewed by an interagency body annually or more frequently if warranted for adaptive management considerations.

(b) New research information concerning effects of disturbance on marbled murrelet nesting behavior, suitable stand size for murrelet management areas, and survey protocol should be incorporated into these guidelines as they become available.

b. Other Species Benefited by Standards and Guidelines for Marbled Murrelet

The following species whose viability is at risk under Alternative B of the Final Environmental Impact Statement are likely to be protected if they occur within areas protected under the guidelines for Riparian Habitat Conservation Areas or marbled murrelets. It seems likely that much of the distribution of these species is included in such protected areas.

(1) Nonvascular Plants:

(a) *Teloschistes flavicans* (Lichen) Only one site is known for this species, Cape Lookout, Oregon, adjacent to land managed by the Forest Service. It occurs in the coastal fog belt in large, old, coastal Sitka spruce forest, it may occur in National Forests but surveys are needed.

(b) *Herbertus sakuraii* (Liverwort) This species is extremely rare, occurring only on Saddle Mountain, Coast Range, Oregon. Fog drip environment is significant. This species occurs in coastal Sitka spruce fog belt, There is a need to survey for the species on Mt. Hebo, Onion Mt., and Sugarloaf Mt.,

Coast Range, Oregon, and to protect habitats from ground disturbance if found. Other liverwort species associated with the same habitats and ranges as H. sakuraii, and likely to be equally benefited by mitigation options for marbled murrelet, include *Iwiatsukella leucotricha, Radula brunnea, Tritomaria quinquedentata,* and *Apometzgeria pubescens.*

(c) *Bartramiopsis lescurii* (Moss) This species occurs in low to mid elevations the west slopes of the Olympic Mountains on wet organic soils. It is extremely rare. There is a need to protect from ground disturbance known sites and additional sites as found. As an interim measure, mitigation options for marbled murrelet will help protect known sites for this species.

(d) *Pleuroziopsis ruthenica* (Moss) This species is included in the species group with Bartramiopsis lescurii above, with the same conditions and benefits from mitigation options for marbled murrelet.

(e) *Collybia racemosa* (Fungus) This mushroom is rare, known to occur in six sites in the Quinault Research Natural Area in Washington in well established old-growth forest. It is perhaps more common in coastal old-growth forests, but needs surveys, studies, and inventories. In the interim, mitigation measures for marbled murrelet will help protect known sites for this species.

(f) *Albatrellus caeryliopus* (Fungus) This mushroom occurs mostly at lower elevations in the Olympic Peninsula, Cortez island, and Mt. Hood National Forest. Other mushroom species sharing similar habitats and ranges that would also benefit from mitigation options for marbled murrelet are *Catathelasma ventricosa* (widely distributed), *Cortinarius boulderensis*, *Cortinarius cyanites, Cortinarius olympianus, Cortinarius rainierensis* (only known site is Barlow Pass and Mount Rainier), *Cortinarius tabularis* (occurs on spruce trees in Quinault Research Natural Area, Washington), *Cortinarius valgus* (occurs on spruce trees in Quinault Research Natural Area, Washington), *Cortinarius variipes*, and *Gomphus kauffmannii*. Although not required as a standard, additional surveys for all of these species would better define their distribution and the need for any additional protection. However, in the interim, mitigation measures for marbled murrelet will help protect known sites for this species.

(2) Amphibians:

Clouded Salamander - This species requires large (>20 inches in diameter) down logs of mid-decay classes (decay classes 2-4 preferred) with sloughing bark. The species is well distributed within its range, which closely coincides with that of the northern spotted owl in California and Oregon (clouded salamanders do not occur in Washington). Late-successional forest protected for marbled murrelets, Riparian Habitat Conservation Areas, Alternative B as described in the Final Environmental Impact Statement (or its modification as presented in Chapter 3), and existing Land and Resource Management Plan standards and guidelines for management of down logs will likely provide sufficient habitat to assure well distributed viable populations of this species in National Forests within the range of the northern spotted owl.

(3) Birds:

Northern Goshawk - Although some protection for northern goshawk habitat is afforded by the Riparian Habitat Conservation Areas discussed above, additional protection is needed to help ensure viability within the range of the northern spotted owl. Under the interim marbled murrelet standards and guidelines, nearly all of the mature or old-growth forest in the Olympic National Forest that is otherwise unprotected outside of Habitat Conservation Areas under Alternative B of the Final Environmental Impact Statement will be protected, Therefore, nearly all potential nesting habitat in the Olympic National Forest will be protected from timber harvest. The Olympic Peninsula is an area of particular concern because northern goshawks are believed to be relatively isolated there, they occur in low numbers, and their habitat requirements have not been well documented. Experts strongly suspect that old-growth forests are vital for nesting. Protection of habitat under the combination of Alternative B of the Final Environmental Impact Statement, Riparian Habitat Conservation Areas, and marbled murrelet guidelines provides broad latitude for natural catastrophes and uncertainties in knowledge.

In addition, the bird expert panel recommended the following mitigation measures: save mistletoe trees, especially on the east slope of the Cascades, protect nest stands of pairs located outside of Habitat Conservation Areas, and conduct further research on the distribution and ecology of the species throughout its range. The following forest management activities would help conserve suitable habitat conditions for the species: retain the upper forest canopy at known or suspected nest sites; retain down wood and logs for prey, principally squirrel species; and manage stands for understory removal and canopy retention. We believe that such conditions would be provided under Mitigation Steps 1 through 4.

(4) Mammals:

American Marten (populations in Olympic Peninsula and Oregon Coast Range) - with northern goshawk, protection for American marten is afforded by the Riparian Habitat Conservation Areas discussed above. However, additional protection is needed for American marten habitat to help ensure viability within the range of the northern spotted owl. Interim guidelines for marbled murrelets on the Olympic Peninsula will also provide substantial benefit to protection of American marten habitat on the Olympic Peninsula, especially in combination with Alternative B of the Final Environmental Impact Statement, and watershed protection. Murrelet guidelines plus Riparian Habitat Conservation Areas will also contribute to American marten viability within the range of murrelets on the Oregon Coast Range and coastal northern California.

c. Adoption, of Recovery Plan for Marbled Murrelet

Once a final recovery plan for marbled murrelets is adopted, the new standards and guidelines must be evaluated to determine whether the set of other species protected by the interim standards and guidelines will still be adequately protected. If an area of habitat is removed from protection, the area should be surveyed for the species listed in this section prior to undertaking any site-disturbing activity and, if necessary, site-specific management prescriptions should be prepared to meet the habitat requirements of these species.

Mitigation Step 5 - Standards and Guidelines for Rare, and Locally Endemic Species.

As with the set of species listed in the above category, the following rare and locally endemic species are likely to be assured viability if they occur within Habitat Conservation Areas conserved by Alternative B of the Final Environmental Impact Statement, Riparian Habitat Conservation Areas, or areas covered under the marbled murrelet guidelines. However, there might be occupied locations outside these conservation areas that will be important to protect as well. We therefore recommend that protocols for surveys be developed that will ensure a high likelihood of locating these occupied sites. Prior to ground disturbing activities, surveys using tile protocol must be conducted within the known or suspected ranges and within the habitat types or vegetation communities occupied by the species. When located, the occupied sites need to be protected as indicated below.

(1) Nonvascular Plants:

(a) *Ptilidium californicum* (Liverwort) This species is rare and has a very limited distribution in old white fir forests with fallen trees. It occurs on trunks of trees at about 5000 feet elevation. Mitigation options include finding locations and maintaining stands of over mature white fir at about 5000 feet elevation for inoculum and dispersal along corridors; and studying specific distribution patterns. Protect known occupied locations if distribution patterns are disjunct and highly localized, by deferring timber harvest and avoiding removal of fallen trees and logs.

(b) *Ulota megalospora* (Moss) This species occurs in northern California and southwest Oregon. It is best developed (locally abundant) in very old stands of tanoak, Douglas-fir, and other conifer species further north, but is generally scarce throughout its range. The species is poorly known ecologically. Mitigation activities include conducting basic ecological studies, and surveying for presence, particularly in Oregon. Protect known occupied sites if distribution patterns are disjunct and highly localized. Defer timber harvest or other activities which would not maintain desired habitat characteristics and population levels.

(c) *Brotherella roellii* (Moss) This very rare species is endemic to the Washington Cascades north of Snoqualmie Pass. It occupies rotting logs in low to mid elevation old-growth stands having dense shade, closed canopies, and high humidity. Mitigation options include locating specific populations and protection of large decay class 3, 4, and 5 logs and >70 percent canopy closure. Defer management activities conflicting with maintaining suitable habitat characteristics and known population levels.

(d) *Buzbaumia piperi, B. viridis, Rhizomnium nudum, Schistostega pennata*, and *Tetraphis geniculata* (Mosses) Most of these species are fairly rare (the exception is *B. piperi*). They occur on rotten logs and some organic soil, and are shade-dependent, occurring in old-growth forests. *S. pennata* occurs only in mature western red-cedar forests in the Olympic National Forest and in Washington Cascades. Mitigation activities include surveying to determine presence and distribution; and, where located, maintaining decay

class 3, 4, and 5 logs and >70 percent closed-canopy forest habitats for shade. Shelterwood and thinning prescriptions for timber harvest will cause their demise, as logs dry out.

(e) *Aleuria rhenana* (Fungus) This mushroom is widely distributed but rare and little known throughout its range, known from one collection from Mt. Rainier National Park. It is a conifer litter decomposer. Mitigation activities include conducting ecological studies and surveys to determine localities. Protect known populations if surveys continue to indicate that the population is rare. Defer ground disturbing activities.

(f) *Otidea leporina, O. onotica*, and *O. smithii* (Fungi) These mushrooms occur in conifer duff, and are widespread in distribution but uncommon. They are dependent on older age forests. Specific mitigation options include protecting older forests from ground disturbance where the species are located.

(g) *Polyozellus multiplez* (Fungus) Ecologically, this mushroom was considered by the nonvascular expert panel in the same species group as Albatrellus caeryliopus and others, listed above under species aided by marbled murrelet mitigation measures. However, *P. multiplez* occurs in higher elevation of the Cascades in silver fir and mixed conifer (and is thus outside the range of marbled murrelet mitigations). It can be locally abundant and is mychorrizal species important to forest health. Like its group associates, it is a good indicator of old-growth forests. Mitigation activities for this species include conducting surveys to define its distribution, and studies to assess its habitat requirements.

(h) *Sarcosoma mexicana* (Fungus) This mushroom occurs in deep conifer litter layers in older forests. It is uncommon to rare and is found in the Oregon and Washington Coast Range into British Columbia. Mitigation activities include surveying for locations and protecting deep litter layers of older forests where found. Defer prescribed burning of understory or other activities which would not retain a deep litter layer.

For all of the plants listed in this mitigation step, and for those listed in the next step, we recommend that Regional ecologists or botanists should: (1) maintain spatially explicit data base of all known sites in National Forests, and (2) develop species or area management plans, to be implemented under the guidance of the regional botany programs.

(2) Invertebrates:

Although lack of information prevented us from analyzing mitigation needs for specific invertebrate species, Olson (1992) underscored the need for surveys for species that are rare or locally endemic. Within the range of the northern spotted owl, invertebrates are noted for their high frequency of endemism (species found nowhere else) and restricted ranges. Centers of invertebrate biodiversity include, in particular, the Olympic Peninsula and its south coast, the southern Oregon Cascades, the Klamath physiographic province, several isolated volcanic peaks

including Mt. Hood and the Three Sisters in the Oregon Cascades, and the coastal forests of Oregon and California. In addition, some species are poor dispersers or rely on special habitats including decaying wood or aquatic environments.

Frest and Johannes (1991)identified endemic species complexes of terrestrial molluscs (bivalves and snails) in the west coast states, particularly limited to the areas from the Cascades crest to the coast. As summarized by Anthony et al. (1992:348-349).

> "Within the owl's range, there are three distinct land snail provinces. The Oregon province extends from coastal British Columbia just into extreme northern California; the Washington province extends east from the Cascades crest; and the California province is coastal northern California."
>
> "There are sizable endemic species clusters in the land snail genera *Monadenia, Trilobopsis, Megomphix, Haplotrema, Vespericola* and *Hemphillia.* Physical factors limiting their distribution include geologic history, substrate (some are restricted to limestone, for example, the candidate *Monadenia* troglodytes, endemic to the Siskiyou Mountains and the area around Mt. Shasta), moisture requirements, and cover. In general, land snails in this region require relatively undisturbed cover. Most thrive in lowland forests and the areas around springs. Many species seem to be associated specifically with lowland old-growth forests, and most are extremely limited in distribution. The malone jumping slug, *Hemphillia malonei,* occurs only on the slopes of Mt. Hood. The genus *Megomphiz* is known only from sites in the Puget Sound region and in the Willapa Hills, of southwest Washington. In recent years, only one site has been found to support *Megomphix hemphilli*."

Frest and Johannes (1991) also identified complexes of endemic freshwater molluscs, although the aquatic complexes are not part of our current analysis.

Anthony et al. (1992:355-356) also discussed the occurrence and distribution arthropods in old-growth forests of the Pacific Northwest:

> "First, many species are flightless, which means that their dispersal capabilities are limited. Second, the flightless condition is believed to reflect habitat stability and permanence over a long time period. Some old forest associates have highly disjunct distributions and are found only in undisturbed forests. They share similar distribution patterns on the west side of the Cascade Mountains from British Columbia south to southern Oregon and northern California (i.e., they are endemic to the Pacific Northwest). Many the species native to this region have not been described or named, and the number of known species probably represents less than half of the estimated species (J. Lattin, Oregon State University, pers. comm.)."

Mitigation guidelines for Riparian Habitat Conservation Areas and marbled murrelets would aid in conserving species in biodiversity centers and other areas, as "Habitat Conservation Areas established for owls probably will not capture the full extent of invertebrate species richness. The protection of suitable owl habitat in intervening areas as proposed in Alternative D of the Final Environmental Impact Statement will help :preserve more species distributed over the landscape, but the effectiveness of this provision will be dependent upon the number, size, and isolation of the selected habitat fragments" (Olson 1992:4-5).

Olson (1992) also noted that small fragments of primary forest might serve reserves for populations of old-growth invertebrates. "In regions with a high proportion of species with restricted ranges, such as the Olympic Peninsula, the coastal forests of Washington, Oregon, and California, and the Klamath Province, increased emphasis on preserving small fragments of [old-growth forest] habitat may be warranted" (Olson 1992:15). Such fragments would be provided under combination of the Riparian Habitat Conservation Areas and marbled murrelet guidelines. Elsewhere, some species of invertebrates can be provided for by retaining canopy coverage, providing log and slash piles, and maintaining a moist forest floor environment.

Understanding the true effectiveness of conserving the invertebrate fauna with mitigation measures proposed in our report awaits further surveys, inventories, and studies. Olson (1992:12) proposed using a survey protocol for rapidly identifying biologically unique areas, and in taking advantage of "natural experiments" to investigate the relationships of invertebrate populations to different growth stages and variously fragmented forest patches and landscapes. He presented an excellent research agenda for such studies (too lengthy to repeat here), which included testing and use of invertebrate species as environmental indicators. This agenda should be pursued.

(3) Amphibians:

(a) Larch Mountain Salamander - Because of the narrow distribution of this species, mostly within the Columbia River Gorge, primary emphasis should be to survey and protect all known sites. Sites must be identified based on fall surveys conducted using a standardized protocol. Known sites are included within boundaries of conservation areas and under these guidelines, are not to be disturbed. Surveys are needed at additional sites in the forest matrix along the Columbia River Gorge. Key habitat is mossy talus protected by overstory canopy. Avoiding any ground-disturbing activity that would disrupt the talus layer where this species occurs is the primary means of protection. Once sites are identified, maintain 40 percent canopy closure of trees within the site and within a buffer of at least the height of one site-potential tree or 100 feet horizontal distance, whichever is greater, surrounding the site. Larger buffer widths are appropriate upslope from protected sites on steep slopes. Partial harvest may be possible if canopy closure can be retained; in such cases logging must be conducted using helicopters or high-lead cable systems to avoid disturbance of the talus layer.

(b) Siskiyou Mountain Salamander - This species occurs within an extremely narrow range on the Rogue River, Siskiyou, and Klamath National Forests. Its range does not fall within any Habitat Conservation Areas in Oregon. Additional surveys conducted using a standardized protocol must be undertaken to delineate range and identify subpopulations. All populations must be protected by delineating an occupied site and avoiding disturbance of talus throughout the site, especially on moist, north-facing slopes, particularly in Oregon where Habitat Conservation Areas do not incorporate species' range. Because this species seems to require cool, moist conditions, a buffer of at least the height of one site-potential tree or 100 feet horizontal distance, whichever is greater, surrounding the site, must be retained around the outer periphery of known sites. Overstory trees must not be removed within the boundary of this buffer.

(c) Shasta Salamander - This species is very narrowly distributed, occurring only in localized populations on the Shasta-Trinity National Forest. Only a small part of its range is included within a Habitat Conservation Area under Alternative B. It occurs in association with limestone outcrops, protected by an overstory canopy. All known and future localities must be delineated and protected from timber harvest, mining, quarry activity, and road building within the delineated site, and a buffer of at least the height of one site-potential tree or 100 feet horizontal distance, whichever is greater, should surround the outcrop. Additional surveys, conducted using a standardized protocol, must be undertaken to identify and delineate all occupied sites within the species' potential range.

Mitigation Step 6 - Additional Standards and Guidelines for Other Species in the Upland Forest Matrix.

As with the above sets of species under Mitigation Step 5, the following species whose viability is considered to be at risk under Alternative B of the Final Environmental Impact Statement are likely to be assured viability if they occur within Habitat Conservation Areas of Alternative B of the Final Environmental Impact Statement, Riparian Habitat Conservation Areas, or areas covered under the marbled murrelet guidelines. However, if they are located outside of such areas, additional mitigation measures would be needed to avoid increasing risk to viability. These measures are discussed, by species, below.

(l) Amphibians:

Del Norte Salamander - This species occurs in talus slopes protected by overstory canopy that maintains cool, moist conditions on the ground. The species is a slope-valley inhabitant, and sometimes occurs in high numbers near riparian areas. Riparian Habitat Conservation Areas, in combination with Habitat Conservation Areas and other reserves, will offer some protection to the species but significant numbers also occur in upland areas. Additional mitigation options in this upland matrix include identifying locations (talus areas inhabited by the species) by using standardized survey protocol, then protecting the location from ground-disturbing activities. Designate a buffer of at least the height of one site-potential tree or 100

feet horizontal distance, whichever is greater, surrounding the location. Within the site and its surrounding buffer, maintain 40 percent canopy closure and avoid any activities that would directly disrupt the surface talus layer. Partial harvest within the buffer may be possible if 40 percent canopy closure can be maintained; in such cases, tree harvest must be conducted using helicopters or high lead cable systems to avoid compaction or other disturbance of talus.

(2) Birds:

(a) White-headed Woodpecker, Black-backed Woodpecker, Pygmy Nuthatch, and Flammulated Owl - These species will not be sufficiently aided by application of mitigation measures for riparian habitat protection or for marbled murrelets alone. They all occur on the periphery of the range of the northern spotted owl on the east slope of the Cascade Range in Washington or Oregon. Additionally, white-headed woodpecker and flammulated owl occur in the Klamath Province in northwestern California and southwestern Oregon. The viability of all four species within the range of the northern spotted owl was rated as a medium risk on National Forests, although they each are much more widely distributed elsewhere.

Apply the following mitigation guidelines to ensure that the distribution and numbers of all four species do not severely decline on National Forests within the range of the northern spotted owl. These guidelines apply to the forest matrix outside designated habitat for the northern spotted owl and Riparian Habitat Conservation Areas. Maintain adequate numbers of large snags and green tree replacements for future snags within the four species' ranges in appropriate forest types. Where feasible, green tree replacements for future snags can be left in groups to reduce blowdown. Specifically, we recommend that no snags over 20 inches dbh be marked for cutting. We recognize, however, that safety considerations may prevent always retaining all snags. Use of standardized definitions of hazard trees is required. For the longer term, provide for sufficient numbers of green trees to provide for the full (100 percent) population potential of each species.

As depicted by Neitro et al. (1985), the 100 percent population potential for white-headed woodpeckers is 0.60 conifer snags (ponderosa pine or Douglas-fir) per acre in forest habitats; these snags must be at least 15 inches dbh (or largest available if 15 inch dbh snags are not available) and in soft decay stages (see Neitro et al. 1985 for specifics), and must be provided in stands of ponderosa pine and mixed pine-Douglas-fir. The 100 percent population potential for black-backed woodpeckers is 0.12 conifer snags per acre in forest habitats; these snags must be at least 17 inches dbh (or largest available if 17 inch dbh snags are not available) and in hard decay stages, and must be provided in stands of mixed conifer and lodgepole pine in higher elevations of the Cascade Range. Provision of snags for other cavity-nesting species, including primary cavity-nesters, must be added to the requirements for these two woodpecker species. Site-specific analyses, and application of a snag recruitment model (specifically, the Forest Service's Snag Recruitment Simulator) taking into account tree species, diameters, falling rates, and decay

rates, will be required to determine appropriate tree and snag species mixes and densities. If snag requirements cannot be met, then harvest must not take place.

As identified by the expert panel, black-backed woodpeckers also require beetle-infested trees for foraging; some such trees should be provided in appropriate habitat, and sanitation harvest of all such trees would be detrimental to the species. More information is needed on habitat use, seasonal occurrence, and use of forest age classes and burns, for the black-backed woodpecker.

Pygmy nuthatches use habitats very similar to those of white-headed woodpecker. Pygmy nuthatches require large trees, typically ponderosa pine within the range of the northern spotted owl, for roosting. Provision of snags for white-headed woodpeckers is assumed to provide for the needs of pygmy nuthatch, as no species-specific guidelines for the species have been developed. Additional information on ecology of pygmy nuthatch within the range of the northern spotted owl is needed to develop more precise guidelines.

Flammulated owls are secondary cavity-nesters and use cavities, in snags and live trees, created by woodpeckers or, less often, that occur naturally. We assume that standards and guidelines for snags and green tree replacements for woodpeckers and other primary cavity-nesting species, as provided by existing National Forest Land and Resource Management Plans and for the woodpeckers in this species group, would provide for flammulated owls.

(b) Great Gray Owl - Within the range of the northern spotted owl, the great gray owl is most common in lodgepole pine forests adjacent to meadows. However, it is also found in other coniferous forest types. In some locations, such as on the Willamette National Forest west of the Cascades Crest, at least some shelterwood harvesting seems to be beneficial for the species by opening up otherwise closed canopy cover for foraging. In doing so, consequences to species such as northern goshawk and American marten must be evaluated. Specific mitigation measures for great gray owl, within the range of the northern spotted owl, include the following: provide a no-harvest buffer of 300 feet around meadows and natural openings and establish 1/4-mile protection zones around known nest sites. Within one year, develop and implement a standardized protocol for surveys; survey for nest locations using the protocol. Protect all future discovered nest sites as previously described.

(3) Mammals:

(a) American Marten and Fisher - The level of habitat conservation provided by the combination of Alternative B of the Final Environmental Impact Statement, Riparian Habitat Conservation Areas, and marbled murrelet mitigation guidelines are generally sufficient so that additional standards and guidelines are not required to prevent the extirpation of American martens and fishers within the range of the northern spotted owl. However, we do recommend two additional actions for specific areas to help ensure future viability of these species.

First, the National Forests in California must finalize and implement their draft habitat capability model for fisher and American Marten. Implementation of this model would likely reduce information that will further reduce risks to viability in those National Forests. Forests in Oregon and Washington must retain existing management requirement areas for American marten for the same reason. However, adequacy of these practices must be reevaluated through the ongoing conservation assessment process or through special review. Monitoring and adaptive management are especially important for these species.

Second, populations of fishers are extremely low in northern Oregon and Washington. Harvest of American martens is permitted in these states, and accidental take of fishers cannot be avoided using kill-trap methods. To reduce risk of further loss of fishers, we recommend closure of all National Forests (within the overlapping ranges of American marten, fisher, and northern spotted owls) to kill-trapping of American martens until the rate of accidental take of fishers is determined to be insignificant. We recommend formation of an interagency group comprised of state furbearer biologists and Forest Service wildlife biologists to undertake this evaluation for both states.

(b) Lynx - Lynx are rare within the range of the northern spotted owl, occurring primarily in the Okanogan area of Washington. The lynx is currently listed by the Fish and Wildlife Service as a Category 2 candidate (a species for which additional information is needed to propose listing as threatened or endangered); A petition was filed to list the lynx as endangered within the northern Cascades of Washington, based on small population size, population isolation, and lack of adequate prey base (snowshoe hare). However, the Fish and Wildlife Service ruled that available information does not warrant listing the lynx in Washington (USDI 1992b).

Three primary habitat components for lynx are (1) foraging habitat (15-35 year old lodgepole pine) to support snowshoe hare and provide hunting cover, (2) denning sites (patches of >200-year old spruce and fir, generally acres), and (3) dispersal/travel cover (variable in vegetation composition structure). The major limiting factor is abundance of snowshoe hare, which in turn is limited by availability of winter habitat (primarily early-successional lodgepole pine with trees at least 6 feet tall). Past excessive trapping of lynx and incidental mortality of lynx from hunting of other species have depressed populations and may have been detrimental to local lynx populations in Washington (Washington Department of Wildlife 1991). Roads provide access to hunters and trappers and thus road density may be related to lynx mortality.

Alternative B as described in the Final Environmental Impact Statement, as well as existing higher elevation reserves, will provide denning habitat within protected forest stands in juxtaposition with early successional vegetation in the forest matrix. Connectivity between many of the denning patches will be provided by the network of buffers along streams under the Riparian Habitat Conservation Areas.

In addition, we propose development of site-specific timber harvest, reading,

and fire management plans in known lynx range. These plans should be developed in consultation with state wildlife agencies and should address: (1) minimizing road construction, closing unused roads, and maintaining roads to the minimum standard possible; (2) using prescribed fire to maintain forage for snowshoe hare in juxtaposition with hunting cover; (3) designating areas as closed to kill trapping of any furbearer to avoid incidental lynx mortality to maintain population refugia for lynx in key areas; (4) planning for kill trapping closure on a wider basis if data indicate a declining lynx population as a result of incidental trapping mortality; and (5) developing and implementing a credible survey and monitoring strategy to determine the distribution of lynx throughout its potential range.

Species for Which Information is Most Limited

The amount and quality of information available for old-growth associated species varies significantly from species to species. More information would be useful in developing conservation measures for all these species, including northern spotted owls which are probably the best studied. For this analysis, we have chosen to place the species in three broad categories based on the amount of information available. The first category includes the 459 species for which specific mitigation was described (Table 5-3). The second group includes species for which information was poor, but which are likely to be significantly protected by the mitigation measures due to overlap between their ranges or habitat requirements and the old-growth areas identified in the mitigation steps. The third group includes species for which information is most limited. No conclusion can be drawn about the protection of this third category of species.

In these last two groups, we identified 59 species of nonvascular plants, vascular plants, and terrestrial vertebrates. These are species which the expert panelists identified as lacking scientific studies and whose viability could not be ranked according to general life history attributes and distribution because of the lack of basic information. All 59 species, however, are thought to be closely associated with old-growth forests or components of old-growth forests.

An additional 149 species of invertebrates (58 molluscs and 91 arthropods) were identified from the contract reviews as closely associated with old-growth forests or old-growth forest conditions within the range of the northern spotted owl, or whose specific habitat conditions or future viability could be directly influenced by spotted owl habitat planning. Data were lacking for all 149 invertebrate species so that individual viability assessments under each of the five alternatives in the Final Environmental Impact Statement were not possible. All 149 species - and likely other invertebrate species not included in the contract evaluations - require further study for more specific analysis of potential viability effects.

Thus, in this report, we identified a total of 208 species (59 fungi, lichens, plants, and terrestrial vertebrates; and 149 invertebrates) for which information is most limited. Only 10 species of this total are vertebrates, all of which are mammals. Nine of the mammals are species of bats.

The conservation of old-growth forests under Mitigation Steps 1 through 6 listed previously might provide some of these 208 species with some degree of protection. Some overlap between each of their distributional ranges with those of the old-growth areas may exist. To examine the likelihood of protection, we identified a set of seven ecological conditions which reflected

general distribution or life history patterns suggesting some (unknown) degree of protection from Mitigation Steps 1 through 6. The seven ecological categories of conditions were:

1. Species which may be at least locally common to abundant;

2. Species that are rare to uncommon but are widespread;

3. Species that are locally endemic;

4. Species closely associated with the general types of old-growth forests and conditions afforded by the mitigation steps;

5. Species that are specialized to specific substrates (surfaces) or edaphic conditions (soil and ground conditions), especially those afforded by the mitigation steps;

6. Species occurring in high elevation forests, within the overall range of the northern spotted owl but generally in higher elevation forest types than those used by the northern spotted owl for nesting, roosting, or foraging; and

7. Species whose geographic range overlaps that of the northern spotted owl only along a fringe of the owl's range.

We assumed that habitat conditions for species identified in ecological categories 1 through 5 might be protected by the combination of Mitigation Steps 1 through 6. Species in categories 6 and 7 generally occur outside the ecological or distributional range of the northern spotted owl; and whereas their viability is still of direct concern in this evaluation, their persistence is much more influenced by factors other than those addressed in the spotted owl habitat management guidelines.

According to the results of this evaluation, 23 of the 59 plant and vertebrate species met at least one of the first five ecological conditions, leaving 36 of these species for which effects were truly unknown. The 36 species included 19 nonvascular plants, 8 vascular plants, and 9 mammals (Appendix 5-J).

Effects are also unknown for all 149 invertebrates. Appropriate study should identify the important role of each invertebrate species in old-growth ecosystem processes, and would help identify which set of species could serve as indicators of various aspects of the health of old-growth forests (Olson 1992).

There may be species that we did not identify in our evaluation or to whom we assigned a low risk, that, as more data accumulate, would show close association with late-successional and old-growth forests and that might put such species at viability risk. This is likely the case with at least some species of invertebrates and nonvascular plants. On the other hand, with further scientific study, inventory, and monitoring, some of the species identified in this report as potentially having their viability at risk might turn out to be at less risk than initially suggested. At this time it is impossible to determine without further study which, if any, species would fall into either of these categories. Surveys, research, monitoring, and an adaptive management approach would all be necessary to gather and account for such new information over time.

DISCUSSION AND CONCLUSIONS

Ensuring Effectiveness of the Mitigation Measures

We believe that the combination of (1) forest management standards and guidelines, (2) spotted owl habitat guidelines in Alternative B of the Final Environmental Impact Statement, or their modifications to account for increased risk from Bureau of Land Management management (see Chapter 3), (3) Riparian Habitat Conservation Areas, (4) habitat protection for marbled murrelet, (5) mitigation measures for rare and locally endemic species, and (6) mitigation measures for other species in the upland forest matrix, would collectively provide for a high likelihood of continued existence of well distributed fish habitat and plant and wildlife populations plus northern spotted owls on National Forests. Although it is not possible to predict effects on most invertebrate species, future security of this group is likely to be greatly enhanced under this scheme.

We also strongly urge the application of regional oversight and guidance to ensure consistent interpretation and application of these guidelines and mitigation measures across all pertinent National Forests. An example is the need for development and application of standardized inventory and survey protocols for some species; such protocols should be written by a technical group at the regional or inter-regional level.

Uncertainties of Information and Viability Projections

Ensuring long-term population viability means taking preemptive action to prevent currently secure species from becoming viability risks; identifying species currently at risk; instituting appropriate conservation strategies; and gathering new scientific information on species and ecological conditions where such information is lacking. We believe that these steps collectively constitute a necessary part of any scheme of ecosystem management.

Applying mitigation measures presented herein would provide preemptive actions to help prevent currently secure species from having their viability placed at risk in the future. The list of secure species are those on the short lists (Appendices 5-B, 5-D) that do not appear as viability concerns (Appendix 5-H). However, better inventories are still needed on vegetation conditions that can be used to project the extent, distribution, and trend of habitat for species that are secure and for those whose viability is at risk. Such inventories would also help determine the occurrence of scarce or declining ecological communities and special habitats, which our report addresses only indirectly. Similarly, we could not quantify the locations and frequency of catastrophic events, nor could we map specific locations of future management activities. Both of these factors added uncertainty in our attempt to project the distribution and abundance of habitat over time. We did, however, construct our mitigation steps to attain a high probability of providing for the viability of the species we addressed. This entailed qualitatively accounting for catastrophic events.

Uncertainties associated with identifying viability risk species and mitigation options include the degree to which factors are currently a threat, and the pace at which such threats can be offset by restoring habitat conditions. For many species, such quantitative analyses are not possible without further knowledge of specific habitat associations of species, demography of populations, and dynamics of habitat changes, including changes from anthropogenic (human-induced) and ecological (such as succession, fire regimes, etc.) factors. Uncertainties in projecting future

viability were recognized by the Scientific Analysis Team and by the expert panels, who depicted uncertainties as ranges of potential future viability effects.

Uncertainties associated with species lacking adequate scientific information underscore the need for basic life history and ecology studies, and inventories for presence and habitat associations. Studies and inventories are needed on a variety of plant, invertebrate, and some vertebrate species. Such basic data will allow agencies to move toward more credible, ecologically-based management that will sustain biological diversity and production of commodity renewable resources.

In particular, increasing scientific knowledge on invertebrates can help develop monitoring and adaptive management activities for management of old-growth forest ecosystems. For example, Olson, (1992: 27-28) noted that, "forest invertebrate assemblages can serve as excellent tools for adaptive management programs. The effect of harvesting schedules and management practices on local ecosystem vigor can be assessed rapidly, and appropriate changes can be made in a timely fashion. Invertebrates are also useful for long-term monitoring of ecosystem viability on both a local and regional scale." Olson presented a list of 14 potential invertebrate indicator taxa and species for monitoring old-growth forests ecosystems, from H.J. Andrews Experimental Forest on the west slope of the northern Oregon Cascades. An example from this list is the millipede *Harpaphe haydeniana* (Diplopoda: Xestodesmidae), a widespread species vital for nutrient cycling in the soil because it is a dominant decomposer of coniferous litter (also see Lattin and Moldenke 1992). Other potential invertebrate indicators presented by Olson (1992: 47-48) include species of camel crickets, sowbugs, weevils, true bugs, ground beetles, wood-boring beetles, cursorial spiders, mites, ants, and earthworms. This is an obviously rich and untapped area worthy of further study.

Toward Ecosystem Management

We emphasize the need to treat our viability evaluations and proposed mitigation measures as preliminary management hypotheses. All species that we identified as associated with old growth, and particularly those that we identified as having medium or high risk of extirpation, require further basic research, monitoring of habitat amount and distribution, and, in some cases, monitoring of specific population distribution, size, and trend.

This project is but an initial step in a larger process for supporting ecosystem management, planning, and evaluation. There is still a great deal of basic work to do to support ecologically-based land stewardship. There are no quick fixes given the complexities of natural environmental systems.

References

Anthony, R.T.; Williams, J.; Bart, C., [and others]. 1992. Consideration of other species and ecosystem concerns. Pages 329-412 in: USDI. Recovery plan for the northern spotted owl - draft. Washington, DC: U.S. Department of the Interior. 662 p.

Asquith, A.; Lattin, L.D.; Moldenke, A.R. 1990. Arthropods: the invisible diversity. The Northwest Environmental Journal. 6: 404-405.

Bjornn, T.C.; Reiser, D.W. 1991. Habitat requirements of salmonids in streams. Special Publication 19. American Fisheries Society. 83-138 p.

Brown, E.R. 1985. Management of wildlife and fish habitats in forests of western Oregon and Washington. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 332 p. 2 vols.

Frest, T.J.; Johannes, E.J. 1991. Present and potential candidate mollusks occurring within the range of the northern spotted owl. Final Report Contract #P53354. Prepared for Northern Spotted Owl Recovery Team. U.S. Department of the Interior, Fish and Wildlife Service. 30 p.

Groot, C.; Margolis, L., eds. 1991. Pacific salmon life histories. Vancouver, BC: UBC Press. 564 p.

Hamer, T.; Cummins, E. 1992. Washington, DC: Federal Register. 57(191): 45329-45377.

Johnson, K.N.; Franklin, J.F.; Thomas, J.W.; Gordon, J. 1991. Alternatives for management of late-successional forests of the Pacific Northwest. Scientific Panel on Late-Successional Forest Ecosystems. A report to the Agriculture and Merchant and Marine Fisheries Committees of the U.S. House of Representatives. Washington, DC.

Lattin, J.D.; Moldenke, A,R. 1992. Ecologically sensitive invertebrate taxa of Pacific Northwest old-growth conifer forests. Report prepared for the Northern Spotted Owl Recovery Team Other Species and Ecosystems Committee, U.S. Department of the Interior, Fish and Wildlife Service. Corvallis, OR: Oregon State University, Department of Entomology. 42 p. + figs.

National Marine Fisheries Service. 1990. Endangered and threatened species, Sacramento winter-run chinook salmon. Washington, DC: Federal Register. 55: 46515-46523.

Nehlsen, W.; Williams, J.E.; Lichatowich, J.A. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries. 16(2): 4-21.

Neitro, W.A.; Binkley, V.W.; Cline, S.P., [and others]. 1985. Snags (wildlife trees). Pages 129-169 in: Brown, E.R., ed. Management of wildlife and fish habitats in forests of western Oregon and Washington. Part 1 - chapter narratives. Portland, OR: U.S. Department of Agriculture, Forest Service.
332 p.

Olson, D. 1992. The northern spotted owl conservation strategy: implications for Pacific Northwest forest invertebrates and associated ecosystem processes. Final report prepared for the

Northern Spotted Owl EIS Team, U.S Department of Agriculture, Forest Service. Portland, OR: The Xerces Society. 51 p. + map.

Ralph, C.J.; Nelson, S.K. 1992. Methods of surveying marbled murrelets at inland forested sites. Pacific Seabird Group, Marbled Murrelet Technical Committee. 21 p. Unpublished report.

Reeves, G.H.; Everest, F.H.; Sedell, J.R. [In press]. Diversity of juvenile anadromous salmonid assemblages in basins in coastal Oregon, U.S.A. with different levels of timber harvest. Proceedings of the American Fisheries Society.

Ricker, W.E. 1972. Heredity and environmental factors affecting certain salmonid populations. Pages 19-160 in: Simm R.C.; Larkin, P.A., eds. The stock concept in Pacific salmon. Vancouver, BC: University of British Columbia.

Ruggiero, L.F.; Aubry, K.B.; Carey, A.B.; Huff, M.H. 1991. Wildlife and vegetation of unmanaged Douglas-fir forests. Gen. Tech. Rep. PNW-GTR-285. U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station.

Thomas, J.W.; Forsman, E.D; Lint, J.B., [and others]. 1990. A conservation strategy for the northern spotted owl: a report of the Interagency Scientific Committee to address the conservation of the northern spotted owl. Portland, OR: U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior, Bureau of Land Management, Fish and Wildlife Service, and National Park Service. 427 p.

USDA Forest Service. 1992a. Background report for development of the Forest Service management strategy for Pacific salmon and steelhead habitat. Washington DC: U.S. Department of Agriculture, Forest Service.

USDA Forest Service. 1992b. Chapter 2630: management of wildlife and fish habitat, northern goshawk. Interim directive no. R-6 2630; draft. 3 p.

USDA Forest Service. 1992c. Final environmental impact statement on management for the northern spotted owl in the National Forests. Portland, OR: U.S. Department of Agriculture, Forest Service, National Forest System. 2 vol.

USDI. 1992a. Recovery plan for the northern spotted owl - draft. Portland, OR: U.S. Department of the Interior. 662 p.

USDI Fish and Wildlife Service. 1992b. Washington, DC: Federal Register. 57(94): 46007-46012.

Washington Department of Wildlife. 1991. Management recommendations for Washington's priority habitats and species. Olympia, WA: Washington Department of Wildlife.

Williams, J.E.; Johnson, J.E.; Hendrickson, D.A. 1989. Fishes of North America endangered, threatened, and of special concern. Fisheries. 14(6): 2-20.

Appendix 5-A

Terrestrial Vertebrates Associated With Late-Successional and Old-Growth Forests in National Forests Within the Range of the Northern Spotted Owl ("Long List")

Table of Contents

Appendix 5-A
Terrestrial Vertebrates ("Long List")

Key

This list consists of species of amphibians, reptiles, birds, and mammals that constitute the "long list". The objective was to include all old-growth/mature associated species within the range of the northern spotted owl. A species was put on the list if any of the references indicated use of mature or old-growth (late-successional) forest habitat or features (down logs or large snags). The species on this list may not be dependent or closely associated with mature or old-growth forests or their components but may merely be reported to use one of these habitats.
Nine references were used to identify species for this long list (listed here in order of appearance in the table):

RP = USDI (1992)
UF - Ruggiero et al. (1991)
SVO = Marshall (1992)
LSO = Marcot et al. (in prep.)
PS = Rodrick and Milner (1991)
KP = Foster (1992) and Macfarlane et al. (1991)
OFW = Marshall (1991)
WOW = Brown (1985)
CWH = California Department of Fish and Game (see description below)

To clarify how the selection of species was done, the following about the references should be noted:

Species from Brown (1985; coded as WOW) were included if they were denoted as primary or secondary user of large sawtimber or old-growth forest age classes in evergreen hardwood, conifer hardwood, mixed coniferous, temperate, high temperate, subalpine park or lodgepole pine forests. The latter three types were included because they are considered dispersal habitat for the spotted owl.

Species from California Department of Fish and Game's Habitat Relationship System (1989 version; coded as CWH) were sorted for those species associated with mixed conifer or Douglas-fir forest types, medium or large tree forest age classes, and moderate (40-59 percent) or dense (60-100 percent) crown closure classes.

Species from Ruggiero et al. (1991:456-462; coded as UF) were included if they were denoted as present (P), associated (+), or closely associated (*) with the mature old-growth age classes.

Species from the Draft Recovery Plan for the Northern Spotted Owl (USDI 1992:341,343,346; coded as RP) were included as listed in their Table D.1 (birds), Table D.2 (mammals), or Table D.3 (amphibians and reptiles).

Appendix 5-A
Terrestrial Vertebrates ("Long List")

Key (continued)

For the remaining references, the narratives for each species were reviewed. If association with late-successional forest habitats or features were indicated, the species were included on the list.

Other codes used in the column headings:

USFWS = USDI Fish and Wildlife Service
WA = Washington
OR = Oregon
CA = California
OG = old-growth forest
Endemic - degree of endemism in the Pacific Northwest; Loc - locally endemic, Broa = broadly distributed throughout the Pacific Northwest within the range of the northern spotted owl
Columns labeled A through I = see text, Table 5-1, for factors for identifying species closely associated with old-growth forests
Columns labeled 1 through 4"= see text, Table 5-1, for criteria for identifying species closely associated with old-growth forests
Conclusion = indicated if a species is included in the "short list" of species closely associated with old-growth forests

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Amphibians

Species	References									Information from USFWS Draft Recovery Plan (Anthony et al.)								
	RP	UF	SVO	LSO	PS	KP	OFW	WO	CWH	USFWS listing status	State listing WA	State listing OH	State listing CA	OG assoc. WA	OG assoc. OR	OG assoc. CA	Endemic Loc	Endemic Broa	OG assoc Reference
Amphibians																			
Oregon Slender salamander	x	x	x	x			x	x				SC			+		X		Ruggiero et al. 1991
Larch Mt. salamander	x		x		x		x	x		C2	C	SC			•		X		Beatty et al. 1991
Siskiyou Mt. salamander	x		x				x	x	x	C2		SC	T				X		Beatty et al. 1991
Del Norte salamander	x	x	x	x			x	x	x	C2		SC	SC			•	X		Ruggiero et al. 1991
Van Dyke's salamander	x				x			x		C3	C			+			X		Beatty 1991 pers. comm.
Mount Lyell salamander									x										
Dunn's salamander	x	x		x	x			x			C				+	?	X		Ruggiero et al. 1991
Western red-backed salamander	x	x						x									X		Ruggiero et al. 1991
Black salamander	x	x	x					x	x			SC						X	Ruggiero et al. 1991
California slender salamander		x	x	x				x											
Clouded salamander	x	x	x	x			x		x			SC			+	+	X		Ruggiero et al. 1991
Arboreal salamander									x										
Ensatina	x	x		x				x								•			Ruggiero et al. 1991
Pacific giant salamander	x	x		x				x	x					+	+	•		X	Raphael 1988
Cope's giant salamander	x	x	x	x			x							+	?		X		Ruggiero et al. 1991
Olympic salamander	x	x	x	x			x	x	x			SC	SC	SC	+	•	•	X	Ruggiero et al. 1991
Northwestern salamander	x	x		x				x	x					•	+	?	X		Ruggiero et al. 1991
Shasta salamander	x								x	C2			T				X		Beatty et al. 1991
Red bellied newt									x										
Roughskin newt		x		x				x	x					•					Ruggiero et al. 1991
Pacific treefrog		x						x	x										
Tailed frog	x	x	x	x			x	x	x			SC	SC	SC	+	+	•	X	Ruggiero et al. 1991
Cascades frog	x		x					x		C2		SC	SC				X		Beatty et al. 1991
Red-legged frog	x	x	x							C2		SC	SC			?		X	Ruggiero et al. 1991
Western spotted frog	x		x		x					C2	C	SC							Beatty et al. 1991
Foothill yellow-legged frog	x	x	x							C2		SC	SC		?			X	Ruggiero et al. 1991
Western Toad	x								x										Beatty 1991 pers. comm.
Northern leopard frog																			

Appendic 5-A
Terrestrial Vertebrates ("Long List") - Amphibians (continued)

	More abundant in OG forest				Species lists				
	field data	SAT judgment	Assoc w/ OG forest	Requires OG elements	Federal USFWS T&E	Federal USFWS Candidat	USFS sensitive species	State list	Inadeq. field data
Species	A	B	C	D	E	F	G	H	I
Amphibians									
Oregon Slender salamander			x	x				x	
Larch Mt. salamander	x					x	R6	x	
Siskiyou Mt. salamander			x	x		x	R6	x	
Del Norte salamander	x		x	x		x	R6	x	
Van Dyke's salamander			x	x		x		x	
Mount Lyell salamander									
Dunn's salamander			x	x				x	
Western red-backed salamander									
Black salamander		x						x	
California slender salamander			x	x					
Clouded salamander			x	x				x	
Arboreal salamander				x					x
Ensatina			x						
Pacific giant salamander	x	x?	x						
Cope's giant salamander		x?	x				R6		x
Olympic salamander	x							x	
Northwestern salamander	x								
Shasta salamander		x?				x		x	x?
Red-bellied newt									
Roughskin newt	x		x						
Pacific treefrog									
Tailed frog	x							x	
Cascades frog						x		x	
Red-legged frog						x	R6	x	
Western spotted frog						x		x	
Foothill yellow-legged frog						x		x	
Western Toad									
Northern leopard frog									

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Amphibians (continued)

Species	Criteria for assigning species to old-growth associated list				Conclusion On old-growth associated list? *	Comments
	1	2	3	4		
Amphibians						
Oregon Slender salamander		x			YES	uses down logs
Larch Mt. salamander	x		x		YES	also protected in forest plans
Siskiyou Mt. salamander		x			YES	threatened in Calif.
Del Norte salamander	x	x	x		YES	
Van Dyke's salamander		x			YES	uses down logs
Mount Lyell salamander					no	
Dunn's salamander		x			YES	not known if late seral required
Western red-backed salamander					no	
Black salamander	x				YES	
California slender salamander		x			YES	
Clouded salamander		x			YES	
Arboreal salamander					no	widespread; & wide variety of habitat conditions
Ensatina					no	ubiq.; uses small down wood
Pacific giant salamander	x				YES	Gomez 1992, Raphael 1988
Cope's giant salamander	x				YES	assumes similar ecology as w/ Pac. Giant Sal.
Olympic salamander	x		x		YES	
Northwestern salamander	x				YES	
Shasta salamander	x				YES	
Red-bellied newt					no	
Roughskin newt	x				YES	
Pacific treefrog					no	
Tailed frog	x		x		YES	
Cascades frog					no	
Red-legged frog					no	
Western spotted frog					no	
Foothill yellow-legged frog					no	
Western Toad					no	
Northern leopard frog					no	

* "old-growth associated list" = "short list" (see Appendix 5-D)

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Reptiles

Species	References: [illegible]	[illegible]	SVC	LSOI	PS	AP	CFW	WO	CWH
Reptiles									
Western pond turtle	x		x	x					
Sharp tailed snake	x		x						
Rubber boa								x	
Gopher snake									x
Western aquatic garter snake									x
Western terrestrial garter snake									x
Common garter snake									x
Western rattlesnake									x
Northern alligator lizard		x							x
Western fence lizard									x

Species	USFWS listing status	State listing WA	State listing OR	State listing CA	OG assoc. WA	OG assoc. OR	OG assoc. CA	Endemic Loc	Endemic Broad	OG assoc. Reference
	Information from USFWS Draft Recovery Plan (Anthony et al.)									
Western pond turtle	C2	T	SC	SC					X	Beatty et al. 1991
Sharp tailed snake			SC						X	Beatty et al. 1991
Rubber boa										
Gopher snake										
Western aquatic garter snake										
Western terrestrial garter snake										
Common garter snake										
Western rattlesnake										
Northern alligator lizard										
Western fence lizard										

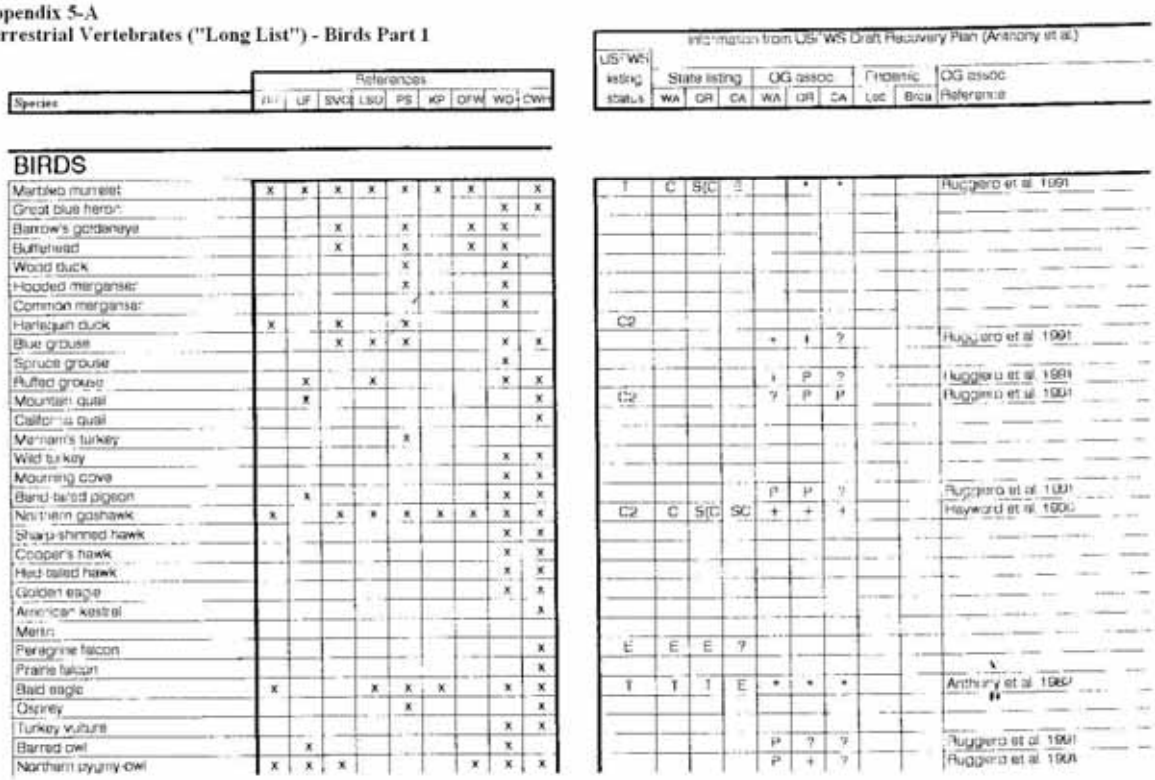
Species	More abundant in old forest: field data	More abundant in old forest: SAT judgment	Assoc w/ old forest	Requires old elements	Species lists: Federal USFWS T&E	Species lists: Federal USFWS Candidate	Species lists: USFS sensitive species	Species lists: State list	Inadeq. field data
	A	B	C	D	E	F	G	H	I
Reptiles									
Western pond turtle						x	R6	x	
Sharp tailed snake				x				x	
Rubber boa									
Gopher snake									
Western aquatic garter snake									
Western terrestrial garter snake									
Common garter snake									
Western rattlesnake									
Northern alligator lizard									
Western fence lizard									

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Reptiles (continued)

Species	Criteria for assigning species to old growth associated list: 1	2	3	4	Conclusion: On old-growth associated list? *	Comments
Reptiles						
Western pond turtle					no	
Sharp tailed snake					no	
Rubber boa					no	
Gopher snake					no	
Western aquatic garter snake					no	
Western terrestrial garter snake					no	
Common garter snake					no	
Western rattlesnake					no	
Northern alligator lizard					no	
Western fence lizard					no	

* "old-growth associated list" = "short list" (see Appendix 5-D)

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 1



Species	References								
	[illegible]	UF	SWO	LSU	PS	KP	OFW	WO	CWH
BIRDS									
Marbled murrelet	X	X	X	X	X	X	X		X
Great blue heron								X	X
Barrow's goldeneye			X		X		X	X	
Bufflehead			X		X		X	X	
Wood duck					X			X	
Hooded merganser					X			X	
Common merganser								X	
Harlequin duck	X		X		X				
Blue grouse			X	X	X			X	X
Spruce grouse								X	
Ruffed grouse		X		X				X	X
Mountain quail		X							X
California quail									X
Merriam's turkey					X				
Wild turkey								X	X
Mourning cove								X	X
Band-tailed pigeon		X						X	X
Northern goshawk	X		X	X	X	X	X	X	X
Sharp-shinned hawk								X	X
Cooper's hawk								X	X
Red-tailed hawk								X	X
Golden eagle								X	X
American kestrel									X
Merlin									
Peregrine falcon									X
Prairie falcon									X
Bald eagle	X			X	X	X		X	X
Osprey					X				X
Turkey vulture								X	X
Barred owl		X						X	
Northern pygmy-owl	X	X	X				X	X	X

Information from USFWS Draft Recovery Plan (Anthony et al.)									
USFWS listing status	State listing			OG assoc			Historic		OG assoc Reference
	WA	OR	CA	WA	OR	CA	Loc	Broa	
	T	C	SC	?		*	*		Ruggiero et al. 1991
C2									
					*	?	?		Ruggiero et al. 1991
					?	P	?		Ruggiero et al. 1991
C2					?	P	P		Ruggiero et al. 1991
					P	P	?		Ruggiero et al. 1991
C2	C	SC	SC		+	+	+		Hayward et al. 1990
E	E	E	?						
T	T	T	E	*	*	*			Anthony et al. 1986
									"
					P	?	?		Ruggiero et al. 1991
					P	+	?		Ruggiero et al. 1991

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 1 (continued)

	More abundant in OG forest			Requires OG	Species lists				Inadeq.
	field data	SAT judgment	Assoc w/ OG forest	elements	Federal USFWS T&E	Federal USFWS Candidat	USFS sensitive species	State list	field data
Species	A	B	C	D	E	F	G	H	I
BIRDS									
Marbled murrelet	x		x	x	x		R6	x	x
Great blue heron									
Barrow's goldeneye			x	x					
Bufflehead			x	x					
Wood duck			x	x					
Hooded merganser			x	x					
Common merganser			x	x					
Harlequin duck			x	x		x	R6		
Blue grouse								x	
Spruce grouse									
Ruffed grouse								x	
Mountain quail						x			
California quail									
Merriam's turkey									
Wild turkey									
Mourning dove									
Band-tailed pigeon									
Northern goshawk		x				x		x	
Sharp-shinned hawk									
Cooper's hawk									
Red-tailed hawk									
Golden eagle									
American kestrel									
Merlin									
Peregrine falcon					x		R6	x	
Prairie falcon									
Bald eagle	x	x			x		R6	x	x
Osprey				x					
Turkey vulture									
Barred owl			x	x					
Northern pygmy-owl			x	x?					

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 1 (continued)

Species	Criteria for assigning species to old-growth associated list: 1	2	3	4	Conclusion: On old-growth associated list? *	Comments
BIRDS						
Marbled murrelet	X	X	X	X	YES	recently listed as Threatened
Great blue heron					no	
Barrow's goldeneye		X			YES	riparian management for snags
Bufflehead		X			YES	riparian management for snags
Wood duck		X			YES	riparian management for snags
Hooded merganser		X			YES	riparian management for snags
Common merganser		X			YES	riparian management for snags
Harlequin duck		X			YES	riparian management for snags
Blue grouse					no	
Spruce grouse					no	
Ruffed grouse					no	
Mountain quail					no	
California quail					no	
Merriam's turkey					no	
Wild turkey					no	
Mourning dove					no	
Band-tailed pigeon					no	
Northern goshawk	X				YES	Reynolds references; OG associated on Olymp. Pen.
Sharp-shinned hawk					no	
Cooper's hawk					no	
Red-tailed hawk					no	
Golden eagle					no	
American kestrel					no	
Merlin					no	
Peregrine falcon					no	
Prairie falcon					no	
Bald eagle	X		X	X	YES	
Osprey					no	snags, esp. along lakes, rivers
Turkey vulture					no	
Barred owl		X			YES	Brown lists elements incl. snags
Northern pygmy-owl		X			YES	check factor D?; Brown lists snags

* "old-growth associated list" = "short list" (see Appendix 5-D)

l Vertebrates ("Long List") - Birds Part 2

	References								
	RP	UF	SVO	LSO	PS	KP	OFW	WO	CWH
d owl	x	x		x	x	x	x	x	x
l	x		x	x	x		x		x
	x		x			x	x		x
n owl									x
wl								x	x
								x	x
het owl								x	x
awk									x
									x
bird		x		x					
gbird								x	
gbird		x		x				x	x
swift									x
	x	x		x	x	x	x	x	x
									x
								x	
aow								x	x
r								x	
ecker	x	x	x	x	x		x	x	x
cker		x							x
ker		x		x				x	x
oodpecker	x		x		x		x	x	x
oodpecker	x		x		x		x	x	
cker			x				x		
ker		x		x			x	x	x
dpecker		x					x		
ecker									x
		x		x				x	x
		x		x				x	x
		x		x				x	x
ker (1)								x	x
apsucker	x	x		x				x	x
psucker			x				x	x	x

Information from USFWS Draft Recovery Plan (Anthony et al.)									
USFWS listing status	State listing			OG assoc.			Endemic		OG assoc. Reference
	WA	OR	CA	WA	OR	CA	Loc	Broa	
T	T	T	?	*	*	*			Ruggiero et al. 1991
					+	+			Ruggiero et al. 1991
	C			P	+			X	Ruggiero et al. 1991
	C			*	*	?			Ruggiero et al. 1991
	C	S(C		+	+	+			Ruggiero et al. 1991
				?	P	?			Ruggiero et al. 1991
	C	S(C		+	*	*		X	Bull 1990
	M	S(C		+	+				Goggans et al. 1987
				P	+	P			Ruggiero et al. 1991
				+	P	P			Ruggiero et al. 1991
				P	+	P			Ruggiero et al. 1991

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 2 (Continued)

Species	More abundant in OG forest: field data A	More abundant in OG forest: SAT judgment B	Assoc w/ OG forest C	Requires OG elements D	Species lists: Federal USFWS T&E E	Species lists: Federal USFWS Candidat F	Species lists: USFS sensitive species G	Species lists: State list H	Inadeq field data I
Northern spotted owl	x				x		R6	x	
Flammulated owl			x	x					
Great gray owl			x	x					
Western screech owl									
Great horned owl									
Long-eared owl									
Northern saw-whet owl									
Common nighthawk									
Whip-poor-will									
Allen's hummingbird									
Calliope hummingbird									
Rufous hummingbird								x	
White-throated swift									
Vaux's swift	x			x				x	
Black swift									
Tree swallow				x					
Violet-green swallow									
Belted kingfisher								x	
Pileated woodpecker			x	x					
Downy woodpecker				x					
Hairy woodpecker	x			x				x	
White-headed woodpecker			x	x				x	
Black-backed woodpecker			x	x					
Acorn woodpecker				x					
Lewis woodpecker				x					
Three-toed woodpecker			x	x					
Nuttall's woodpecker				x					
Common raven									
Gray jay									
Steller's jay									
Clark's nutcracker (1)									
Red-breasted sapsucker		x		x					
Williamson's sapsucker			x	x					

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 2 (continued)

Species	Criteria for assigning species to old-growth associated list				Conclusion: On old-growth associated list? *	Comments
	1	2	3	4		
Northern spotted owl	x		x		YES	
Flammulated owl		x			YES	occurs in NSO range only in nw CA? Goggans 1986
Great gray owl		x			YES	E. Bull references
Western screech owl					no	
Great horned owl					no	
Long-eared owl					no	
Northern saw-whet owl					no	
Common nighthawk					no	
Whip-poor-will					no	
Allen's hummingbird					no	
Calliope hummingbird					no	
Rufous hummingbird					no	
White-throated swift					no	
Vaux's swift	x		x		YES	closely assoc. w/ OG; WA candidate
Black swift					no	
Tree swallow					no	
Violet-green swallow					no	
Belted kingfisher					no	
Pileated woodpecker		x			YES	
Downy woodpecker					no	uses small snags
Hairy woodpecker	x		x		YES	closely assoc. w/ OG in no. CA (Raphael 1988)
White-headed woodpecker		x			YES	uses large snags; Bull reference
Black-backed woodpecker		x			YES	uses large snags; Goggans et al. 1987
Acorn woodpecker					no	assoc. w/ oak woodlands, hardwood components
Lewis woodpecker					no	
Three-toed woodpecker		x			YES	Brown lists as using snags; Goggans et al. 1987
Nuttall's woodpecker					no	
Common raven					no	
Gray jay					no	
Steller's jay					no	
Clark's nutcracker (1)					no	
Red-breasted sapsucker	x				YES	
Williamson's sapsucker		x			YES	

* "old-growth associated list" = "short list" (see Appendix 5-D)

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 3

Species	References								
	RP	UF	SVO	LSO	PS	KP	OFW	WO	CWH
Northern flicker		x		x				x	x
Dusky/Hammond's flycatcher		x		x					x
Western flycatcher	x	x		x				x	x
Olive-sided flycatcher		x		x				x	x
Hammond's flycatcher	x	x						x	x
Willow flycatcher	x			x		x			
Western wood-pewee		x						x	x
Black-capped chickadee		x						x	
Chestnut-backed chickadee	x	x		x				x	x
Mountain chickadee								x	x
Brown creeper	x	x		x				x	x
Red-breasted nuthatch	x	x		x				x	x
White breasted nuthatch		x						x	x
Pygmy nuthatch			x				x	x	x
Winter wren	x	x		x				x	x
House wren		x							
Western bluebird									x
Mountain bluebird									
Golden-crowned kinglet		x						x	x
Ruby-crowned kinglet		x						x	x
American robin		x		x					x
Hermit thrush	x	x		x				x	x
Swainson's thrush		x		x				x	x
Townsend's solitaire		x						x	x
Varied thrush		x		x				x	x
Wrentit		x		x					
Cedar waxwing									x
Brewer's blackbird									x
Hermit/Townsend's warbler		x						x	
MacGillivray's warbler		x							
Black-throated gray warbler		x						x	x
Nashville warbler		x							x
Hermit warbler		(x)						(x)	x

Information from USFWS Draft Recovery Plan (Anthony et al.)									
USFWS listing status	State listing			OG assoc.			Endemic		OG assoc. Reference
	WA	OR	CA	WA	OR	CA	Loc	Brea	
				P	+	P			Ruggiero et al. 1991
					+				Ruggiero et al. 1991
				P	*	+			Ruggiero et al. 1991
								X	
				P	P	*			(see comments)
				P	P	P			Ruggiero et al. 1991
				?	P			X	Ruggiero et al. 1991
				+	+	+			Ruggiero et al. 1991
				+	*	*			Ruggiero et al. 1991
				+	?	?			Ruggiero et al. 1991
				?	P	?			Ruggiero et al. 1991
				+	+	+			Ruggiero et al. 1991
				+	+	+			Ruggiero et al. 1991
				?	P	?			Ruggiero et al. 1991
				P	P	P			Ruggiero et al. 1991
				?	P	?			Ruggiero et al. 1991
				P	+	+			Ruggiero et al. 1991
				P	P	+			Rugg. et al. 91, Raphael 1986
				+	P	?			Rugg. et al. 91
	C	S(C		+	+	+			Goggans 1986
			E	+	+	P			Ruggiero et al. 1991
				P	P	+			Ruggiero et al. 1991
				P	P				Ruggiero et al. 1991
				P	P	?			Ruggiero et al. 1991
				P	P	P			Ruggiero et al. 1991
				?	P	P			Ruggiero et al. 1991
				?	P	+			Ruggiero et al. 1991

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 3 (continued)

Species	More abundant in OG forest: field data (A)	More abundant in OG forest: SAT judgment (B)	Assoc w/ OG forest (C)	Requires OG elements (D)	Species lists: Federal USFWS T&E (E)	Federal USFWS Candidat (F)	USFS sensitive species (G)	State list (H)	Inadeq. field data (I)
Northern flicker			x	x					
Dusky/Hammond's flycatcher									
Western flycatcher	x								
Olive-sided flycatcher									
Hammond's flycatcher	x								
Willow flycatcher									
Western wood-peewee									
Black-capped chickadee									
Chestnut-backed chickadee		x							
Mountain chickadee	•								
Brown creeper	x			x					
Red-breasted nuthatch			x	x					
White breasted nuthatch			x	x					
Pygmy nuthatch			x	x					
Winter wren		x							
House wren									
Western bluebird									
Mountain bluebird									
Golden-crowned kinglet		x							
Ruby-crowned kinglet									
American robin									
Hermit thrush		x							
Swainson's thrush									
Townsend's solitaire								x	
Varied thrush		x						x	
Wrentit									
Cedar waxwing									
Brewer's blackbird									
Hermit/Townsend's warbler		x							
MacGillivray's warbler									
Black-throated gray warbler									
Nashville warbler									
Hermit warbler									

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 4

Species	References									Information from USFWS Draft Recovery Plan (Anthony et al.)								
										USFWS listing status	State listing			OG assoc			Endemic		OG assoc Reference
	RP	UF	SVO	LSO	PS	KP	OFW	WO	CWH		WA	OR	CA	WA	OR	CA	Lsc	Brds	
Orange-crowned warbler		x						x	x					?	P	P			Ruggiero et al. 1991
Townsend's warbler		x						(x)	x					?	P	?			Ruggiero et al. 1991
Yellow warbler									x										
Wilson's warbler	x	x		x				x						+	P	*			Ruggiero et al. 1991, Raphael 1985 (CA)
Yellow-rumped warbler		x						x	x					P	P	P			Ruggiero et al. 1991
Hutton's vireo		x							x					P	P	P			Ruggiero et al. 1991
Solitary vireo		x		x				x	x					P	+	+			Ruggiero et al. 1991
Warbling vireo	x	x						x	x					P	P	P			Ruggiero et al. 1991
Western tanager		x		x				x	x					P	P	+			Ruggiero et al. 1991
Chipping sparrow		x												?	P	?			Ruggiero et al. 1991
Dark-eyed junco		x						x						P	P	P			Ruggiero et al. 1991
Rufous-sided towhee		x												?	P	P			Ruggiero et al. 1991
Song sparrow		x												P	P	?			Ruggiero et al. 1991
Black-headed grosbeak		x		x					x					P	+	+			Ruggiero et al. 1991
Evening grosbeak		x						x	x					P	P	P			Ruggiero et al. 1991
Pine grosbeak								x											
Pine siskin		x		x				x	x					P	P	P			Ruggiero et al. 1991
Purple finch		x						x	x					P	P	P			Ruggiero et al. 1991
Cassin's finch									x										
Red crossbill		x		x				x	x					+	+	P			Ruggiero et al. 1991
White-winged crossbill							x												
Common redpoll							x												

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 3 (continued)

Species	Criteria for assigning species to old-growth associated list				Conclusion: On old-growth associated list? *	Comments
	1	2	3	4		
Northern flicker		x			YES	assoc. w/ open forests, but uses lg snags
Dusky/Hammond's flycatcher					no	
Western flycatcher	x				YES	assoc. w/ OG in no. Cal. (Raphael 1988)
Olive-sided flycatcher					no	
Hammond's flycatcher	x				YES	Ruggiero et al. 1991; Sakai & Noon 1991 (CA)
Willow flycatcher					no	
Western wood-peewee					no	
Black-capped chickadee					no	
Chestnut-backed chickadee	x				YES	assoc. w/ OG in no. Cal. (Raphael 1988)
Mountain chickadee					no	
Brown creeper	x				YES	assoc. w/ OG in no. Cal. (Ruggiero et al. 1991)
Red-breasted nuthatch		x			YES	uses smaller snags; Brown lists in mature & OG
White breasted nuthatch		x			YES	uses smaller snags; Brown lists in mature & OG
Pygmy nuthatch	*	x			YES	uses smaller snags; Brown lists in mature & OG
Winter wren	x				YES	assoc. w/ OG in no. Cal. (Raphael 1988)
House wren					no	
Western bluebird					no	
Mountain bluebird					no	
Golden-crowned kinglet	x				YES	assoc. w/ OG in no. Cal. (Raphael 1988)
Ruby-crowned kinglet					no	
American robin					no	
Hermit thrush	x				YES	assoc. w/ OG in no. Cal. (Raphael 1988)
Swainson's thrush					no	
Townsend's solitaire					no	
Varied thrush	x				YES	assoc. w/ OG in no. Cal. in winter
Wrentit					no	
Cedar waxwing					no	
Brewer's blackbird					no	
Hermit/Townsend's warbler	x				YES	see individual species ratings
MacGillivray's warbler					no	
Black-throated gray warbler					no	
Nashville warbler					no	
Hermit warbler					no	

* "old-growth associated list" = "short list" (see Appendix 5-D)

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 4 (continued)

Species	More abundant in oo forest: field data (A)	More abundant in oo forest: SAT judgment (B)	Assoc w/ oo forest (C)	Requires oo elements (D)	Species lists: Federal USFWS T&E (E)	Species lists: Federal USFWS Candidat (F)	Species lists: USFS sensitive species (G)	Species lists: State list (H)	Inadeq field data (I)
Orange-crowned warbler									
Townsend's warbler		x	x						
Yellow warbler									
Wilson's warbler	x								
Yellow-rumped warbler									
Hutton's vireo									
Solitary vireo									
Warbling vireo		x							
Western tanager									
Chipping sparrow									
Dark-eyed junco									
Rufous-sided towhee									
Song sparrow									
Black-headed grosbeak									
Evening grosbeak									
Pine grosbeak									
Pine siskin									
Purple finch									
Cassin's finch									
Red crossbill			x	x					
White-winged crossbill									
Common redpoll									

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 4 (continued)

Species	Criteria for assigning species to old-growth associated list				Conclusion: On old-growth associated list? *	Comments
	1	2	3	4		
Orange-crowned warbler					no	
Townsend's warbler	x				YES	mature (Brown '85, Marcot '85), OG (Brown '85)
Yellow warbler					no	
Wilson's warbler	x				YES	in OG in no. Cal. (Raphael 1985), but also in yng grth
Yellow rumped warbler					no	
Hutton's vireo			/		no	
Solitary vireo					no	
Warbling vireo	x				YES	assoc. w/ OG in no. Cal. (Raphael 1988)
Western tanager					no	
Chipping sparrow					no	
Dark-eyed junco					no	
Rufous-sided towhee					no	
Song sparrow					no	
Black-headed grosbeak					no	
Evening grosbeak					no	
Pine grosbeak					no	
Pine siskin					no	
Purple finch					no	
Cassin's finch					no	
Red crossbill		x			YES	large canopy, no fragmentation; species complex
White-winged crossbill					no	
Common redpoll					no	

* "old-growth associated list" = "short list" (see Appendix 5-D)

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Mammals Part 1

Species	References								
	RP	UF	SVO	LSO	PS	KP	OFW	WO	CWH
MAMMALS									
Marten	x		x	x	x	x	x	x	x
Ermine		x						x	x
Long-tailed weasel								x	x
Fisher	x	x	x	x	x	x	x	x	x
Wolverine	x			x			x	x	
Gray wolf	x			x					
Black bear								x	x
Grizzly bear	x			x				x	
Porcupine								x	x
Mountain beaver									x
Brush rabbit								x	
Raccoon								x	x
Ringtail							x		
Opposum								x	
Dusky-footed woodrat	x							x	x
Bushy-tailed woodrat	x			x				x	x
Northern flying squirrel	x	x		x				x	x
Western gray squirrel					x			x	x
Golden mantled ground squirrel								x	x
Cascade mantled ground squirrel								x	
Siskiyou chipmunk								x	x
Yellow pine chipmunk (1)									x
Yellow-cheeked chipmunk									x
Allen's chipmunk									x
California chipmunk									x
Douglas squirrel		x		x				x	x
Townsend's chipmunk		x						x	
Red tree vole (P.longicaudus)	x	x		x				x	x
Red tree vole (P.pomo)	x	x		x				x	x
White-footed vole	x		x	x				x	
Western red-backed vole	x	x		x				x	x

Information from USFWS Draft Recovery Plan (Anthony et al.)									
USFWS listing status	State listing			OG assoc.			Endemic		OG assoc. Reference
	WA	OR	CA	WA	OR	CA	Loc	Broa	
	G	S	S	+	+	+			Marshall 1991
				?	P	?			Ruggiero et al 1991
C2	S	S	SC	+	+	+			Ruggiero et al. 1991
C2	M	T	T						
E	E								
T	E								
		SC				*		X	Raphael 1985,88
								X	
		SC	?	*	?				Carey 1992 (OR)
				?	?	*			Raphael 1988 (CA)
					*				Rosenberg & Anthony 1992
					*		X		Ruggiero et a. 1991; Gomez 1992
		SC			+		X		Ruggiero et al 1991
C2		S(R)	SC				X		Gomez 1992
						*	X		Raphael 1988

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Mammals Part 1 (continued)

Species	More abundant in OG forest: field data (A)	More abundant in OG forest: SAT judgment (B)	Assoc w/ OG forest (C)	Requires OG elements (D)	Species lists: Federal USFWS T&E (E)	Federal USFWS Candidat (F)	USFS sensitive species (G)	State list (H)	Inadeq. field data (I)
MAMMALS									
Marten			x	x				x	
Ermine									
Long-tailed weasel									
Fisher			x	x		x		x	
Wolverine						x	R6	x	x
Gray wolf					x		R6	x	
Black bear									
Grizzly bear					x		R6	x	
Porcupine									
Mountain beaver									
Brush rabbit									
Raccoon									
Ringtail									
Opposum									
Dusky-footed woodrat	x		x					x	
Bushy-tailed woodrat									
Northern flying squirrel	x		x	x				x	
Western gray squirrel									
Golden mantled ground squirrel									
Cascade mantled ground squirrel									
Siskiyou chipmunk									
Yellow pine chipmunk (1)									
Yellow cheeked chipmunk									
Allen's chipmunk									
California chipmunk									
Douglas squirrel	x		x	x					
Townsend's chipmunk	x								
Red tree vole (P longicaudus)	x		x					x	
Red tree vole (P.pomo)		x	x						
White-footed vole						x	R6	x	x
Western red-backed vole	x			x					

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Mammals Part 1 (continued)

Species	Criteria for assigning species to old-growth associated list: 1	2	3	4	Conclusion: Or old-growth associated list? *	Comments
MAMMALS						
Marten		x			YES	uses snags & down logs for den sites
Ermine					no	assoc. w/ early succ. stages too
Long-tailed weasel					no	assoc. w/ early succ. stages too
Fisher		x			YES	uses snags & down logs for den sites
Wolverine					no	high elev./subalpine associate
Gray wolf					no	
Black bear					no	
Grizzly bear					no	
Porcupine					no	
Mountain beaver					no	most abund. in early growth stages
Brush rabbit					no	
Raccoon					no	
Ringtail					no	
Opposum					no	
Dusky-footed woodrat	x		x		YES	also in early shrub stages; but CC use > mid-succ.
Bushy-tailed woodrat					no	
Northern flying squirrel	x	x	x		YES	
Western gray squirrel					no	
Golden mantled ground squirrel					no	
Cascade mantled ground squirrel					no	
Siskiyou chipmunk					no	
Yellow pine chipmunk (1)					no	
Yellow-cheeked chipmunk					no	
Allen's chipmunk					no	
California chipmunk					no	
Douglas squirrel	x	x			YES	requires lg conifers w/ seed production
Townsend's chipmunk	x				YES	but also is abundant in early stages
Red tree vole (P.longicaudus)	x				YES	recov plan shows OR only
Red tree vole (P.pomo)	x				YES	recov plan shows CA only
White-footed vole					no	riparian assoc.; not sig. across serat stages (Gomez)
Western red-backed vole	x				YES	

* "old-growth associated list" = "short list" (see Appendix 5-D)

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Mammals Part 2

Species	References									Information from USFWS Draft Recovery Plan (Anthony et al.)								
										USFWS listing status	State listing			OG assoc.			Endemic		OG assoc Reference
	RP	LF	SVO	LSO	PS	KP	OFW	WO	CWH		WA	OR	CA	WA	OR	CA	Loc	Broa	
Heather vole (1)								x											
Southern red-backed vole		x						x						P					Ruggiero et al. 1991
Forest deer mouse	x	x		x										+			X		Ruggiero et al. 1991
Deer mouse		x		x					x					+	+	*			Rug. 91 (WA,OR); Raph 88 (CA)
Western jumping mouse									x										
Pacific jumping mouse									x										
Pinyon mouse		x							x							P			Ruggiero et al. 1991
Marsh shrew		x		x											+				Ruggiero et al. 1991
Montane shrew		x	*											P	P	P			Ruggiero et al. 1991
Masked shrew								x											
Dusky shrew								x											
Trowbridge's shrew		x						x	x					P	P	P			Ruggiero et al. 1991
Pacific shrew		x		x					x						+	*			Rugg 91 (OR); Raph 88 (CA)
Vagrant shrew		x						x						P	P	?			Ruggiero et al. 1991
Coast mole		x												P	P	?			Ruggiero et al. 1991
Shrew-mole	x	x		x				x	x					P	+	?			Ruggiero et al. 1991
Big brown bat		x		x				x	x						*				Ruggiero et al. 1991
Silver-haired bat	x	x		x				x	x					+	*	?			Ruggiero et al. 1991
Western (Townsend's) big-eared bat	x									C?	C	S(C	SC						
Pallid bat								x											
Hoary bat								x	x										
Brazilian free-tailed bat								x											
Red bat									x										
Long-legged myotis	x	x		x				x	x		M			*	*	?			Ruggiero et al. 1991
Yuma myotis		x		x				x	x					*	*	?			Ruggiero et al. 1991 (Myotis A complex)
California myotis		x		x				x	x					*	*	?			Ruggiero et al. 1991 (Myotis B complex)
Keen's myotis		x		x										*	*	?			Ruggiero et al. 1991 (Myotis B complex)
Long-eared myotis		x		x				x	x					*	*	?			Ruggiero et al. 1991 (Myotis B complex)
Western small-footed myotis		x		x					x					*	*	?			Ruggiero et al. 1991 (Myotis B complex)
Fringed myotis		x		x										?	*	?			Ruggiero et al. 1991
Little brown myotis		x		x				x	x					*	*	?			Ruggiero et al. 1991 (Myotis A complex)
Black-tailed deer								x											
Mule deer								x	x										

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Mammals Part 2 (continued)

Species	More abundant in oo forest: field data (A)	More abundant in oo forest: SAT judgment (B)	Assoc w/ oo forest (C)	Requires oo elements (D)	Species lists: Federal USFWS T&E (E)	Federal USFWS Candidat (F)	USFS sensitive species (G)	State list (H)	Inadeq. field data (I)
Heather vole (1)									
Southern red-backed vole		x		x					x
Forest deer mouse		x?	x						
Deer mouse	x		x						
Western jumping mouse									
Pacific jumping mouse									
Pinyon mouse									
Marsh shrew									
Montane shrew									
Masked shrew			x						
Dusky shrew			x						x
Trowbridge's shrew			x						
Pacific shrew	x		x						
Vagrant shrew									
Coast mole			x						
Shrew-mole		x?	x						x
Big brown bat	x			x					
Silver-haired bat	x			x					
Western (Townsend's) big-eared bat						x	R6	x	
Pallid bat			x						
Hoary bat			x	x					
Brazilian free-tailed bat									
Red bat									
Long-legged myotis	x		x	x				x	
Yuma myotis	x		x	x					
California myotis	x		x	x					
Keen's myotis	x		x	x					
Long-eared myotis	x		x	x					
Western small-footed myotis	x		x	x					
Fringed myotis	x								
Little brown myotis	x		x	x					
Black-tailed deer									
Mule deer									

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Mammals Part 2 (continued)

Species	Criteria for assigning species to old-growth associated list				Conclusion: On old-growth associated list? *	Comments
	1	2	3	4		
Heather vole (1)					no	
Southern red-backed vole	x				YES	little data available
Forest deer mouse	x				YES	
Deer mouse	x				YES	data show OG, but also very abund. in early seral veg.
Western jumping mouse					no	
Pacific jumping mouse					no	
Pinyon mouse					no	assoc. w/ early seral stages
Marsh shrew					no	strong riparian assoc. (Gomez 92)
Montane shrew					no	
Masked shrew					no	boreal, widespread species
Dusky shrew					no	
Trowbridge's shrew					no	broad assoc. w/ all forest stages
Pacific shrew	x				YES	abund in young forest (Gomez 92) but taxonomy uncertain
Vagrant shrew					no	low elev, early stage assoc. (Gomez 92) but tax. uncertain
Coast mole					no	fossorial, tied to soil structure
Shrew-mole	x				YES	regional OG analysis shows "*" (Aubry)
Big brown bat	x				YES	Christy & West in press; comb. w/ fringed in Rugg. et al. '91
Silver- haired bat	x				YES	Christy & West in press
Western (Townsend's) big-eared bat					no	Christy & West in press
Pallid bat					no	cliffs and caves (Ingles 1967)
Hoary bat		x			YES	Christy & West in press
Brazillian free-tailed bat					no	assoc. w/ caves (Brown 1985)
Red bat					no	
Long-legged myotis	x	x	x		YES	Christy & West in press
Yuma myotis	x	x			YES	part of "Myotis A" group in Ruggiero et al. 1991
California myotis	x	x			YES	part of "Myotis B" group in Ruggiero et al. 1991
Keen's myotis	x	x			YES	part of "Myotis B" group in Ruggiero et al. 1991
Long-eared myotis	x	x			YES	part of "Myotis B" group in Ruggiero et al. 1991
Western small-footed myotis	x	x			YES	part of "Myotis B" but NOT OG associated
Fringed myotis	x				YES	? combined w/ big brown bat in Ruggiero et al. 1991
Little brown myotis	x	x			YES	part of "Myotis A" group in Ruggiero et al. 1991
Black-tailed deer					no	
Mule deer					no	

* "old-growth associated list" = "short list" (see Appendix 5-D)

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Mammals Part 3

Species	References									Information from USFWS Draft Recovery Plan (Anthony et al.)								
	RP	UF	SVD	LSO	PS	KP	OFW	WO	CWH	USFWS listing status	State listing WA	State listing OR	State listing CA	OG assoc. WA	OG assoc. OR	OG assoc. CA	Endemic Loc	Endemic Brea	OG assoc Reference
Elk					x			x	x										
Mountain lion								x	x										
Lynx					x					C2									

Species	More abundant in og forest: field data A	More abundant in og forest: SAT judgment * B	Assoc w/ og forest C	Requires og elements D	Species lists: Federal USFWS T&E E	Federal USFWS Candidat F	USFS sensitive species G	State list H	Inadeq. field data I
Elk			x	x					
Mountain lion									
Lynx			x	x		x	R6		

Species	Criteria for assigning species to old-growth associated list: 1	2	3	4	Conclusion: On old-growth associated list? *	Comments
Elk		x			YES	OG assoc. on Olympic Peninsula
Mountain lion					no	
Lynx		x			YES	req. old for. cov. & early seral for feeding; Koehler 1987

* "old-growth associated list" = "short list" (see Appendix 5-D)

Appendix 5-A
Terrestrial Vertebrates ("Long List")

References

Anthony, R.G.; Knight, R.L.; Allen, G.T., [and others]. 1992. Habitat use in the Pacific Northwest. Proceedings of the North American wildlife and natural resources conference. 47: 332-342.

Aubry, K.B.; Crites, M.J.; West, S.D. 1991. Regional patterns of small mammal abundance and community composition in Oregon and Washington. Pages 285-294 in: Ruggiero, L.F.;

Aubry, K.B.; Carey, A.B.; Huff, M.W., eds. Wildlife and vegetation of unmanaged Douglas-fir forests. Gen. Tech. Rep. PNW-GTR-285. Portland, OR: U.S. Department of Agriculture, Forest Service. 533 p.

Beatty, J.J.; Blaustein, A.R.; Storm, R.M. 1992. A report to the Northern Spotted Owl Recovery Team (subgroup addressing other species and older forest ecosystems, Robert G. Anthony, chairperson): the biology of amphibians and reptiles. Corvallis, OR: Oregon State University.

Brown, E.R. 1985. Management of wildlife and fish habitats in forests of western Oregon and Washington. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region. 332 p. 2 vols.

Bull, E.L.; Henjum, M.G.; Rohweder, R.S. 1989. Reproduction and mortality of great gray owls in Oregon. Northwest Science. 63: 38-43.

Bull, E.L.; Peterson, S.R.; Thomas, J.W. 1986. Resource partitioning among woodpeckers in northeastern Oregon. Research Note PNW-444. U.S. Department of Agriculture, Forest Service. 19 p.

Carey, A.B.; Horton, S.P.; Biswell, B.L. 1992. Northern spotted owls: influence of prey base and landscape character. Ecological Monographs. 62(2): 223~250.

Christy, R.E.; West, S.D. [In press]. Biology of bats in Douglas-fir forests. Gen. Tech. Rep. PNW-GTR. U.S. Department of Agriculture, Forest Service.

Foster, M.; Jahola, C.A.; Stewart, R.E. 1992. Biological evaluation for drought related timber salvage on National Forests of the Klamath Province Pacific Southwest Region - USDA Forest Service CY-92 and CY-93. Threatened, endangered, proposed and sensitive plants. San Francisco, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Region. 49 p.

Goggans, R. 1986. Habitat use by flammulated owls in northeastern Oregon. Corvallis, OR: Oregon State University. 54 p. M.S. thesis.

Goggans, R.; Dixon, R.D.; Seminara, L.C. 1987. Habitat use by three-toed and black-backed woodpeckers, Deschutes National Forest, Oregon. Nongame Project 87~3~02. Oregon Department of Fish and Wildlife and U.S. Department of Agriculture, Forest Service, Deschutes National Forest. 50 p. + illus. Unpublished report.

Appendix 5-A
Terrestrial Vertebrates ("Long List")

References (continued)

Gomez, D.M. 1992. Small-mammal and herpetofauna abundance in riparian and upslope areas of five forest conditions. Corvallis, OR: Oregon State University. 118 p. M.S, thesis.

Hayward, G.D.; Holland, T.; Escano, R. 1990. Goshawk habitat relationships. Pages 19-25 in: Warren, N., ed. Old growth habitats and associated wildlife species in the northern Rocky Mountains. Wildlife Habitat Relationships Program Paper No. R1-90-42. U.S. Department of Agriculture, Forest Service, Northern Region.

Ingles, L.G. 1976 (reprinted 1087). Mammals of the Pacific states. Stanford, CA: Stanford University Press. 506 p.

Koehler, G.; Brittell, J. 1990. Managing spruce-fir habitat for lynx and showshoe hares. Journal of Forestry. 88(10): 10-14.

Macfarlane, D.C.; Jahola, C.A.; Stewart, R.E. 1992. Biological evaluation for drought-related timber salvage on National Forests of the Klamath Province Pacific Southwest Region (R5) CY-92 and CY-93. Threatened, endangered, sensitive and proposed animals. San Francisco, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Region. 93 p.

Marcot, B.G. 1985. Habitat relationships of birds and young-growth Douglas-fir in northwestern California. Corvallis, OR: Oregon State University. 282 p. Ph.D. dissertation.

Marcot, B.G.; Huff, M.; Franklin, J.; Reeves, G. [In prep.]. Vegetation and wildlife species associated with late-successional forests of the Pacific Northwest. In: Marcot, B.G.; Perry, C., eds. Alternatives for management of late-successional forests of the Pacific Northwest. Covelo, CA: Island Press.

Marshall, D. 1991. Threatened and sensitive wildlife of Oregon's forests and woodlands. Report prepared for the Audubon Society. Portland, OR. 66 p.

Marshall, D. 1992. Sensitive vertebrates of Oregon. Portland, OR: Oregon Department of Fish and Wildlife.

Raphael, M.G. 1985. Administrative study of relationships between wildlife and old-growth forest stands. Supplement RO-44 under Master Agreement No. 21-395. U.S. Department of Agriculture, Forest Service, Pacific Southwest Region. Berkeley, CA: University of California; final report.

Raphael, M.G. 1988. Long-term trends in abundance of amphibians, reptiles, and mammals in Douglas-fir forests of northwest California. Pages 23-31 in: Szaro, R.C.; Severson, K.E.; Patton, D.R., eds. Management of amphibians, reptiles, and small mammals in North America. Gen. Tech. Rep. RM-166. Flagstaff, AZ: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Appendix 5-A
Terrestrial Vertebrates ("Long List")

References (continued)

Reynolds, R.T.; Meslow, E.C. 1984. Partitioning of food and niche characteristics of coexisting Accipiter during breeding. Auk. 101: 761-779.

Rodrick, E.; Milner, R., tech, eds. 1991. Management recommendations for Washington's priority habitats and species. Olympia, WA: Washington Department of Wildlife.

Rosenberg, D.K.; Anthony, R.G. [In press]. Abundance and habitat relationships of Townsend's chipmunks in second- and old-growth coniferous forests. Journal of Wildlife Management. 57(2).

Ruggiero, L.F.; Aubry, K.B.; Carey, A.B.; Huff, M.H. 1991. Wildlife and vegetation of unmanaged Douglas-fir forests. Gen. Tech. Rep. PNW-GTR-285. Portland, OR: U.S. Department of Agriculture, Forest Service. 533 p.

Sakai, H.F.; Noon, B.R. 1991. Nest-site characteristics of Hammond's and Pacific-slope flycatchers in northern California. Condor. 93: 563-574.

USDI. 1992. Recovery plan for the northern spotted owl - draft. Portland, OR: U.S. Department of the Interior, Region 1. 662 p.

Appendix 5-B

Vascular Plant Species Closely Associated With Old-Growth Forests in National Forests Within the Range of the Northern Spotted Owl ("Short List")

Key for status codes and references appear at the end of this appendix.

Appendix 5-B
Vascular Plant Species Closely Associated with Old-Growth Forests

SCIENTIFIC NAME	COMMON NAME	STATUS FED	WA	OR	CA	CRITERIA FOR OLD-GROWTH ASSOCIATION	REFERENCES
Achtys triphylla	Vanilla leaf					1	13,35,36
Adenocauton bicolor	Trail plant					1	11,14,35,36
Adiantum pedatum	Western maidenhair fern					1	35,36
Altotropa virgata	Candy stick					1	13,35,36,37
Anemone deltoidea	ThreeLeaf anemone					1	35,36
Angelica tomentosa	California angelica					2	11,12
Apocynum pumilum	Dogbane					2	12, 14
Arceuthobium tsugense	Dwarf mistletoe					1	35,36
Arnica latifotia	Mountain arnica					1	35,36,37,38
Asarum caudatum	Wild ginger					1	11,12,35,38
Asarum hartwegii	Wild ginger					2	11, 12
Asarum wagneri	Green-flowered wild ginger			C1		4	
Bensoniella oregana	Bensoniella	C2		C1	R,1B	3	4,8,19
Berberis pumila	Dwarf mahonia					2	11,12
Boschniakia strobilacea	Ground cone					2	11
Botrychium ascendens				C		4	28
Botrychium crenulatum	Southwestern moonwort	C2		C		3	
Botrychium minganense	Victorin's grape fern		S	2		3	24,35,37
Botrychium montanum	Mountain grape-fern			2		3	35,37
Botrychium pumicota	Crater Lake (pumice) grapefern	C1		C1	1A	4	17, 18
Calypso bulbosa	Fairy-Slipper					1	11,13,14,35,36
Chamaecyparis lawsoniana	Port Orford cedar					1	35,38
Chamaecyparis nootkatensis	Alaska yellow cedar					1	35,36,38
Chimaphila menziesii	Pipsissewa					1	35,36
Chimaphilia umbetlata	Common pipsissiwa					1	13,35,36,37
Cimicifuga elata	Tall bugbane		S	C		3	35,37
Ctintonia uniflora	Queen's cup					1	2,12,35,36
Coptis asplenifoIia	Spleenwort-leaved goldthread		S			2	16,25
Coptis laciniata	Goldthread					1	35,36,37
Corallorhiza maculata	Pacific coral root					1	35,36,37
Corallorhiza mertensiana	Western coral-root					1	35,36,37
Cupressus bakeri	Baker's cypress			2		3	19
Cypripedium fasciculatum	Clustered lady's slipper		T	C		4	11
Cypripedium montanum	Mountain lady's slipper					3	8,11,12

Appendix 5-B
Vascular Plant Species Closely Associated with Old-Growth Forests (continued)

SCIENTIFIC NAME	COMMON NAME	STATUS FED	STATUS WA	STATUS OR	STATUS CA	CRITERIA FOR OLD-GROWTH ASSOCIATION	REFERENCES
Pentaria californica	Toothwort					2	13
Oisporum hookeri	Fairy bell					1	13
Dryopteris austriaca	Spreading wood-fern					1	33,36
Eburophyton austiniae	Phantom orchid					1	33,36,37
Erythroniummontanum	Avalanche lily					1	35,36
Fritillaria gentneri	Gentner's mission-bells	C2		C		4	
Gali um kamtschaticum	Boreal bedstraw		S			2	16
Gaultheria humifusa	Western wintergreen					1	35,36
Gaultheria ovatifolia	Oregon wintergreen					1	35,36
Gymnocarpium dryopteris	Oak fern					1	35,36
Habenaria orbiculata	Large round-leaved rein-orchid					1	35,36
Habenaria saccata	Slender bog orchid					1	35,36
Habenaria unalascensis	Alaska rein-orchid					1	35,36
Haplopappus Whitneyi discoides	Whitney haplopappus			2		2	11,12,15
Hemitomes congestum	Gnome plant					2	13,15,35,47
Hieracium scouleri	Woolly-weed					2	39
Hypopitys monotropa	Pinesap					1	13,35,36,37
Lathyris potyphyttus	Leafy peavine					1	35,38
Linnea boreatis longifoLia	(No common name)					2	13
Listera borealis	Northern twayblade		S			3	40
Listera caurina	Western twayblade					1	11,12,35,36,37
Listera convallarioides	Broad-tipped twayblade					1	35,36
Listera cordata	Twayblade				4	1	35,36,37
luzuta hitchcockii	Smooth woodrush					1	35,36
kysichitum americanum	Skunk cabbage					1	35,36
Melica subulata	Melic grass					1	35,38
Menziesia ferruginea	Fool's huckleberry					1	35,36
MiteIta breweri	Brewer's mitrewort					1	35,36
Monotropa uniftora	Indian pipe					1	15,35,36,37
Oxalis oregana	Redwood sorrel					1	13
Phlox adsurgens	Woodiand phlox					2	11,12,13
Picea breweriana	Brewer spruce					1	13,35,38
Pftyopis californica	Pinefoot					2	2,8,35,37
Ptatanthera obtusata	Small northern bog orchid		S			3	25
Pieuricospora fimbriolata	Fimbriate pinesap		S			3	8,13,30,35,37
Poa laxiflora	Loose-flowered bluegrass			2		3	20,31
Polystichum munitum var. imbricans	Imbricate sword-fern					2	11,12
Pterospora andromedea	Woodland pinedrops					1	11,12,15,35,36

Appendix 5-B
Vascular Plant Species Closely Associated with Old-Growth Forests (continued)

SCIENTIFIC NAME	COMMON NAME	STATUS FED	WA	OR	CA	CRITERIA FOR OLD-GROWTH ASSOCIATION	REFERENCES
Pyrota asarifotia	Alpine pyrota					1	2,35,36,37,38
Pyrota chtorantha	Greenish wintergreen					1	35,36
Pyrota dentata	Toothleaf pyrola					1	35,38,39
Pyrola picta	White vein pyrola					1	35,36
Pyrota picta ssp. dentata	Nootka wintergreen					2	11,12
Pyrota secunda	One-sided pyrota					1	35,36,37,38
Pyrola unifiora	Single flowered pyrola					1	35,36
Rubus lasiococcus	Dwarf bramble					1	35,38
Rubus nivalis	Snow bramble					1	35,36,37
Rubus pedatus	Fiveteaved bramble					1	35,36
Sarcodes sanguinea	Snow Plant					2	15
Satureja dougtasii	Yerba buena					1	35,38
Setaginella oregana	Oregon selaginella					1	35,36
Silene nuda	Not available			2		4	17
Smilacina racemosa	Solomons seat					1	13,35,36
Smilacina stellata	Star-flowered solomon-plume					1	35,36
Streptopus amptexifolius	Clasping-leaved twisted-stalk					1	35,36,37
Streptopus roseus	Rosy twisted-stalk					1	35,36
Streptopus streptopoides	Twisted-stalk					1	35,36
Synthyris schizantha	Fringed synthyris					1	35,36
Taxus brevifolia	Pacific yew					1	2,35,36,37,38
Thuja plicata	Western red cedar					1	35,36,37
Tiarella trifoliata	Three-leaved foamflower					1	35,36,37,38
Tiarelfa unifoliata	Coolwort foamflower					1	35,38
Trillium ovatum	Wake-robin					1	13,35,36
Trillium ovatum ssp. oettingeri	Salmon Mtns. Wakerobin				4	1	11
Vaccinium alaskaense	Alaska huckleberry					1	35,36
Vaccinium menbranaceum	Thin-leaved huckleberry					1	35,36,38
Vaccinium ovatifoliufa	Oval-leaf huckleberry					1	35,36
Vaccinium parvifotium	Red huckleberry					1	35,38
Vancouveria hexandra	Inside-out flower					1	11,12,13
Vancouveria planipetala	Inside-out flower					1	11,12,13
Viola americana var. viltosa	American vetch					1	35,38
Viola gtabetla	Pioneer violet					1	35,36
Viola orbiculata	Round-leaved violet					1	35.36
Viola renifolia	Kidney-leaved violet		EX			4	16,33,34
Whipplea modesta	Yerba de Selva					1	13
Xerophyllum tenax	Beargrass					1	35,36,38

Appendix 5-B
Vascular Plant Species Closely Associated With Old-Growth Forests

Key to Status Codes

FED = = = = > Federally Listed Status of a Species.

Codes used:

E =endangered
C =candidate
C1 =category 1 candidate, taxa for which the U.S. Fish and Wildlife Service has sufficient information to support a proposal to list as threatened or endangered under the Endangered Species Act.
C2 =category 2 candidate, U.S. Fish and Wildlife Service candidates that need additional information to propose as threatened or endangered under the Endangered Species Act.
C3 =taxa which have proven to be more abundant or widespread than previously believed and/or which have no identifiable threats. This status is based only on the most recently published Candidate Notice of Review.

WA = = = => Status Listing for Species in Washington

Codes used: Same as codes for Federal.

EX =extinct

OR = = = => Status Listing for Species in Oregon

Codes used: Same as codes for Federal.

CA = = = = > Status Listing for Species in California

Codes used:

Endangered code same as Federal plus:

For State listed plants
E = listed endangered
R = listed rare

Appendix 5-B
Vascular Plant Species Closely Associated With Old-Growth Forests

Key to Status Codes (continued)

For Federal candidates and Federally listed plants

T = Federally listed, threatened
1 = enough data is on file to support the Federal listing
1* = enough data is on file to support Federal listing, but plant presumed extinct
2 = threat and/or distribution data are insufficient to support Federal listing
2* = threat and/or distribution data are insufficient to support Federal listing; presumed extinct
3a = extinct
3b = taxonomically invalid
3c = too widespread and/or not threatened

- California Native Plant Society Codes

1 = List 1; plants extinct, rare or endangered in California and elsewhere
List 1A; presumed extinct
List 1B; rare and endangered in California and elsewhere
2 = List 2; plants rare or endangered in California, but more common elsewhere
3 = List 3; plants about which we need more information
4 = List 4; plants of limited distribution - watch list
Forest Plan Group A; plants most sensitive to habitat manipulation
Forest Plan Group B; plants found in wet meadows, bogs, seeps, etc.
Forest Plan Group C; plants moderately sensitive to habitat manipul.

- California Native Plant Society R-E-D Code

R or "Rarity":

1 = rare, but found in sufficient numbers and distributed widely enough that the potential for extinction or extirpation is low at this time
2 = occurrence confined to several populations or to one extended population
3 = occurrence limited to one or a few highly restricted populations, or present in such small numbers that it is seldom reported

Appendix 5-B
Vascular Plant Species Closely Associated With Old-Growth Forests

Key to Status Codes (continued)

E or "Endangerment":

1 = not endangered
2 = endangered in a portion of its range
3 - endangered throughout its range

D or "Distribution":

1 = more or less widespread outside California
2 = rare outside California
3 = endemic to California

- Forest Service Pacific Southwest Region's Sensitive Plant List 8/90 management sensitivity codes

1 = current or potential threats or jeopardy from Forest management activities
2 = no or minimal threats or jeopardy from Forest management activities
3 = insufficient data at this time to evaluate threats or jeopardy from Forest management activities

Key to criteria for old-growth association: see Table 5-1

Appendix 5-B
Vascular Plant Species Closely Associated With Old-Growth Forests

Reference Codes

1 = number not used
2 = Ruggiero, L.F.; Jones, L.L.C.; Aubry, K.B. 1991b. Plant and animal habitat associations in Douglas-fir forests of the Pacific Northwest: an overview. Pages 447-462 in Ruggiero et al., eds. Wildlife and vegetation of unmanaged Douglas-fir forests. Gem Tech. Rep. PNW-GTR-285. Portland, OR: USDA Forest Service, Pacific Northwest Research Station. 533 p.
3 = number not used
4 = Bingham, personal communication, May 20, 1992.
5 = Topik, Regional Ecologist, personal communication, 1992.
6 = Six Rivers National Forest. October 1992. FWS candidate or sensitive plant species of the Six Rivers National Forest known or suspected to occur in habitat conservation areas.
7 = Diversity Database California Department of Fish & Game, 1992.
8 = Lisa Hoover, Forest Botanist, Forest TE&S Plants Program, Six Rivers National Forest, 1992.
9 = Maria Knight, Forest Botanist, Forest TE&S Plants Program, Klamath National Forest, 1992.
10 = Dave Esle, Forest Botanist, Forest TE&S Plants Program, Mendocino National Forest, 1992.
11 = JuUe Nelson, Forest Botanist, Forest TE&S Plants Program, Shasta-Trinity National Forest, 1992.
12 = Sheila Logan, Zone Ecologist, Ecological Classification Program Data, Shasta-Trinity National Forest, 1992.
13 = Bingham, B. October 1992. Arcata, CA: Old-growth program, Forest Service, Pacific Southwest Research Station.
14 = Vivian Long, Botanist, Shasta-Trinity National Forest, 1992.
15 = Munz, P.A.; Keck, D.D. 1973. A California flora with supplement. Berkeley and Los Angeles, CA: UC Press. 1681 p.
16 = Hitchcock, C.L; Cronquist. 1973. Flora of the Pacific Northwest. Seattle, WA: University of Washington Press.
17 = Carol Tyson, District Botanist, Winema National Forest, 1992.
18 = Cindi O'Neil, District Botanist, Deschutes National Forest, 1992.
19 = Linda Mullens, Botanist, Siskiyou National Forest, 1992.
20 = Larry Scofield, Botany Division of Resources, Salem BLO, Salem, OR., 1992.
21 = number not used
22 = Wayne RoUe, Botanist, Rogue River National Forest, 1992.
23 = Wagner, W.J.; Lord, L.P. 1956. The morphological and cytological distinctress of Botrychium minganence and Botrychium lunaria in Michigan. Bulletin of the Torrey Botanical Club. 83(4): 261-280.
24 = Steve Rust, Botanist, Wenatchee National Forest, 1992.
25 = Laura Potash, Botanist, Mt Baker-Snoqualmie National Forest, 1992.
26 = Meinke, R.J. Threatened and endangered vascular plants of Oregon: an illustrated guide. Portland, OR: U.S. Fish and Wildlife Service.

Appendix 5-B
Vascular Plant Species Closely Associated With Old-Growth Forests

Reference Codes (continued)

27 = Bierly, K.F.; Stockhouse, R.E., II. 1982. Coast fawn lilly (Erythronium revolutum) sensitive species conservation report. Contract # 400-0410-2-384. Prepared for USDA Forest Service, Siuslaw National Forest.
28 = John Gamon, Botanist, Washington National Heritage Program, 1992.
29 = Moldenke, A. 1981. Endangered and threatened plant status report. Eugene, OR: USDA Forest Service, Willamette National Forest.
30 = Species management guide for Pleuricospora fimbriolata. 1988. USDA Forest Service, Gifford Pinchot National Forest.
31 = Species management guide for loose-flowered bluegrass Poa laxiflora. 1988. USDA Forest Service, Siuslaw National Forest.
32 = Linda Kunze, Wetlands Ecologist, Washington Natural Heritage Program, 1992.
33 = An illustrated guide to the endangered, threatened and sensitive vascular plants of Washington. 1981. Olympia, WA: Washington Natural Heritage Program.
34 = Hulten, E. 1968. Flora of Alaska and neighboring territories. Stanford, CA: Stanford University Press.
35 = R-6 Ecology Data Base Analysis (Robin Lesher). Oct - Nov 1992.
36 = Jan Henderson and Robin Lesher, Ecologists, Mt. Baker-Snoqualmie and Olympic National Forests, 1992.
37 = Cindy McCaJn, Ecologist and Jenny Dimling, Botanist, Willamette National Forest, 1992.
38 = Tom Atzet, Pat Martinez and Lisa McCrimmon, Ecologist, Rogue River and Siskiyou National Forests, 1992.
39 = Brad Smith, Ecologist, Wenatchee and Okanogan National Forests, 1992.
40 = George Wooton, Botanist, Okanogan National Forest, 1992.

Additional Sources/References:

Eastman, D.C. 1990. Rare and endangered plants of Oregon. Beautiful America Publishing Co.

Meinke, R.J. 1982. Threatened and endangered vascular plants of Oregon, an illustrated guide.

Oregon Natural Heritage Program. 1991. Rare, threatened and endangered plants and animals of Oregon. Portland, OR.

Siddell, J.L. et al. 1979. Rare, threatened and endangered vascular plants in Oregon, an interim report. Natural Area Preserves Advisory Committee.

Spies, T.A. 1991. Plant species diversity and occurrence in young, mature, and old-growth Douglas-fir stands in western Oregon and Washington. Pages 111-121 in: Ruggiero, L.F.; Aubry, K.B.; Carey. A.B.; Huff, M.H., tech. coords. Wildlife and vegetation of unmanaged Douglas-fir forests. Gen. Tech. Rep. PNW-GTR-285. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 533 p.

Appendix 5-C

Fish Species and Stocks at Risk in National Forests Within the Range of the Northern Spotted Owl

Appendix 5-C
Fish Species and Stocks at Risk in National Forests Within the Range of the Northern Spotted Owl.

Anadromous Fish

Forest	Species/Race	Stock
California		
Mendocino	Chinook	
	Fall	Lower Eel River
	Steelhead Trout	
	Winter	Sacramento River
	Summer	Eel River
Six Rivers	Chinook Salmon	
	Spring/ Summer	Klamath River Smith River
	Fall	Lower Klamath River Tributaries Smith River
	Coho Salmon	Klamath River
	Steelhead Trout	
	Summer	Eel River Mad River Smith River Klamath River
	Coastal Cutthroat	California Coastal Streams
Shasta-Trinity	Chinook	
	Spring/ Summer	Klamath River
	Fall	Lower Klamath River Tributaries
	Stealhead Trout	
	Winter	Sacramento River
	Summer	Klamath River
Klamath	Chinook	
	Spring/ Summer	Klamath River
	Fall	Lower Klamath River Tributaries
	Coho Salmon	Klamath River
	Steelhead Trout	
	Summer	Klamath River

Appendix 5-C
Fish Species and Stocks at Risk in National Forests Within the Range of the Northern Spotted Owl.

Anadromous Fish (continued)

Forest	Species/Race	Stock
Oregon		
Mt. Hood	Chinook Salmon	
	Spring/ Summer	Sandy River
		Hood River
	Fall	Hood River
	Coho Salmon	Clackamas River
		Sandy River
		Hood River
	Steelhead Trout	
	Winter	Lower Columbia River Tributaries above Bonneville Dam
		Clackamas River
		Hood River
		Fifteen Mile Creek
	Summer	Lower Columbia River Tributaries above Bonneville Dam
		Hood River
	Sea-run Cutthroat Trout	Hood River
Willamette	Chinook	Willamette River
	Spring/ Summer	
	Stealhead	Calapooia River
	Winter	
Siuslaw	Chinkook Salmon	
	Spring/ Summer	Alsea River
		Siletz River
	Fall	Yachats River
		Yaquina River
	Coho Salmon	Siuslaw River
		Umpqua River
		Yachats River
		Alsea River

Appendix 5-C
Fish Species and Stocks at Risk in National Forests Within the Range of the Northern Spotted Owl.

Anadromous Fish (continued)

Forest	Species/Race	Stock
Siuslaw (continued)	Coho Salmon	Beaver Creek
		Siletz River
		Salmon River
		Nestucca River
	Chum Salmon	Umpqua River
		Alsea River
		Yaquina River
		Siletz River
		Nestucca River
	Steelhead Trout	
	Winter	Siuslaw River
		Big Creek
		Tenmile Creek
		Yachats River
		Alsea River
		Yaquina River
		Siletz River
		Salmon River
		Nestucca River
	Summer	Siletz River
	Sea-run Cutthroat Trout	Oregon Coastal Streams
Umpqua	Chinook Salmon	
	Spring/ Summer	South Umpqua
	Coho Salmon	Umpqua River
	Chum Salmon	Umpqua River
	Sea-run Cutthroat Trout	Oregon Coastal Streams
Siskiyou	Chinook Salmon	
	Spring/ Summer	Coquille River
	Fall	Winchuck River
		Pistol River
		Rogue River
	Coho Salmon	Winchuck River
		Chetco River
		Pistol River
		Rogue River

Appendix 5-C
Fish Species and Stocks at Risk in National Forests Within the Range of the Northern Spotted Owl.

Anadromous Fish (continued)

Forest	Species/Race	Stock
Siskiyou (continued)	Coho Salmon	Elk River
		Sixes River
		Coquille River
	Chum Salmon	Elk River
		Sixes River
	Steelhead Trout	
	Winter	Illinois River
	Sumer	Rogue River
	Sea-run Cutthroat Trout	Oregon CoastalStreams
Rogue River	Coho Salmon	Rogue River
Washington		
Mt. Baker-Snoqualmie	Chinook Salmon	White River
	Spring/	Stillaguamish River
	Summer	North Fork Nooksack River
		South Fork Nooksack River
	Coho Salmon	Nooksack River
	Steelhead Trout	
	Winter	Nooksack River
	Summer	Stillaguamish River
		Nooksack River
Olympic	Chinook Salmon	Skokomish River
	Spring/	Dosewallips River
	Summer	Dungeness River
		Elwha River
		Wynoochee River
	Fall	Duckabush River
		Dosewallips River
		Dungeness River
	Coho Salmon	Lyre River
		Elwha River
	Chum Salmon	Hood Canal (early-timed)
		Elwha River

Appendix 5-C
Fish Species and Stocks at Risk in National Forests Within the Range of the Northern Spotted Owl.

Anadromous Fish (continued)

Forest	Species/Race	Stock
Olympic (continued)	Pink Salmon	Skokomish River Dungeness River Elwha River
	Steelhead Trout Winter	Skokomish River
	Sea-run Cutthroat Trout	Washington Coastal and Puget Sound Tributaries (except Grays Harbor and Hood Canal Tributaries) Grays Harbor and Hood Canal Tributaries
Gifford Pinchot	Steelhead Trout Winter	Lower Columbia River Tributaries above Bonneville Dam Toutle River Wind River
	Summer	Wind River
	Sea-run Cutthroat Trout	Toutle River Kalama River
Wenatchee	Sockeye Salmon	Wenatchee River
	Steelhead Trout Summer	Wenatchee River Entiat River
Okanogan	Chinook Salmon Spring/ Summer	Methow River Okanogan River
	Steelhead Trout Summer	Methow River Okanogan River

NOTE: Some stocks occur in more than one river system or National Forest.

Appendix 5-C
Fish Species and Stocks at Risk in National Forests Within the Range of the Northern Spotted Owl.

Resident Fish

Forest	Species
Shasta-Trinity	Red-band Trout
Mt. Hood	Red-band Trout
Willamette	Bull Trout
	Oregon Chub
	Oregon Chub
Umpqua	Bull Trout
Rogue River	Bull Trout
Deschutes	Bull Trout
Winema	Bull Trout
Mt. Baker-Snoqualmie	Bull Trout
Olympic	Olympic Mudminnow
Gifford Pinchot	Bull Trout
Wenatchee	Bull Trout
Okanogan	Bull Trout

Species Names

Common Name	Scientific Name
Chinook salmon	*Oncorhynchus tshawytscha*
Coho salmon	*O. kisutch*
Steelhead trout	*O. mykiss*
Redband trout	*O. mykiss gibbsi*
Sea-run cutthroat trout	*O. clarkii clarkii*
Sockey salmon	*O. nerka*
Chum salmon	*O. keta*
Pink salmon	*O. gorbusch*a
Bull trout	*Salvelinus confluentus*
Oregon Chub	*Oregonichthys crameria*
Olympic mudminnow	*Novumbra hubbsi*

References

Nehlsen, W.; Williams, J.W.; Lichatowich, ,J.A. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries. 16(2): 4-21.

Williams, J.E.; Johnson, J.E.; Hendrickson, D.A.; [and others]. 1989. Fishes of North America endangered, threatened, and of special concern. Fisheries. 14(6): 2-20.

Appendix 5-D

Attributes of Terrestrial (Non-Fish) Vertebrates Closely Associated With Old-Growth Forests in National Forests Within the Range of the Northern Spotted Owl ("Short List")

Table of Contents

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Amphibians and Reptiles

P=Primary; S=Secondary
/=most/less use; ( )=equal use; *=spec. hab. req.

Canopy: <=25%; young growth w/ legacies; classic old growth

	Breeding, foraging, and resting habitat												
	Successional stages					Old growth stand structural stages			Microhabitat				
	Young		Mid	Late successional									
Species	Grass/forb	Shrub/sap	Pole	Mature	Old growth	Sparse	Comp	Class. OG	Talus	Logs	Duff/litt	Lg snags	Lg tree
Amphibians													
Oregon Slender salamander	S	P/S	(PS)	(PS)	P/S		X	X		X			
Larch Mt. salamander			S	P	P				X				
Siskiyou Mt. salamander			P	P	P (assumed				X				
Del Norte salamander		*	S/P	S/P	P/S	X			X				
Van Dyke's salamander			S	(PS)	P/S			X	X	X	X		
Dunn's salamander	S	S	S/P	(PS)	P		X	X	X	X	X		
Black salamander	(PS)	(PS)	P/S	(PS)	(PS)	X	X	X	X	X	X		
California slender salamander	S	S/P	(PS)	P/S	P/S		X	X	X	X	X		
Clouded salamander	P	P	(PS)	S	(PS)	X	X	X	X	X	X	X	X
Pacific giant salamander			(PS)	(PS)	P/S	X	X	X	X	X	X		
Cope's giant salamander	P*	P*	(PS)*	(PS)*	P*		X	X			X		
Olympic salamander			P/S	P/S	P				X				
Northwestern salamander	(PS)	(PS)	S	(PS)	P/S		X	X		X	X		
Shasta salamander				P	P	X		X	X	X			
Roughskin newt	(PS)	(PS)	(PS)	P/S	P/S		X	X		X	X		
Tailed frog	S	S	P/S	P/S	P/S		X	X	X	X			

16 amphibian species

Reptiles

* = special habitat features required

0 reptile species

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Amphibians and Reptiles (continued)

Species	Dispersal capability: ~<60 ac (Stand)	~<1-5K ac (Landscape)	across provinces (Range)	Lehmkuhl vulner. risk rating	Brown versatil. rating	Migratory or resident (m or r)	Strong riparian assoc.?
Amphibians							
Oregon Slender salamander	X			28	20	R	
Larch Mt. salamander	X			28	10	R	
Siskiyou Mt. salamander	X			28	16	R	
Del Norte salamander	X				16	R	
Van Dyke's salamander	X			28	18	R	X
Dunn's salamander	X*			24	14	R	X
Black salamander	X				18	R	X
California slender salamander	X				26	R	
Clouded salamander	X			30	22	R	
Pacific giant salamander	X			29	17	R	X
Cope's giant salamander	X					R	X
Olympic salamander	X			29	13	R	X
Northwestern salamander	X			23	19	R	X
Shasta salamander	X					R	X
Roughskin newt	X			23	19	R	X
Tailed frog	X			24	14	R	X
16 amphibian species							
Reptiles							
0 reptile species							

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Amphibians and Reptiles (continued)

	Presence													
	By state			By physiographic province (from Draft Recovery Plan)										
				Washington				Oregon				California		
Species	WA	OR	CA	OLPE	WACA	WACAE	WA Lowln	ORCAW	ORCAE	OCOR	OR KLAM	CA KLAM	CA Cas	CA Coast
Amphibians														
Oregon Slender salamander		X						X	X					
Larch Mt. salamander	X	X			X			X	X					
Siskiyou Mt. salamander		X	X								X	X		
Del Norte salamander		X	X								X	X		X
Van Dyke's salamander	X			X	X	X	X							
Dunn's salamander	X	X	X				X	X	X	X	X			X
Black salamander	*	X	X								X	X	X	X
California slender salamander		X	X								X			X
Clouded salamander		X	X					X	X	X	X	X		X
Pacific giant salamander	X	X	X		X	X	X	X	X	X	X	X	X	X
Cope's giant salamander	X	X		X	X	X	X	X	X	X				
Olympic salamander	X	X	X	X	X	X	X	X	X	X	X	X		X
Northwestern salamander	X	X	X	X	X	X	X	X	X	X	X	X		X
Shasta salamander			X										X	
Roughskin newt	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Tailed frog		X	X	X	X	X		X	X	X	X	X		X
16 amphibian species														
Reptiles														
0 reptile species														

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Amphibians and Reptiles (continued)

Species	not really endemic to the range of the NSO	is endemic to the range of the NSO	very tiny range	qualit. rank: S = scarce everywhere C = common somewhere General abundance within NSO range	Population trend w/in NSO range: Increasing	Stable	Decreasing	References
	Degree of endem ism: Broad	Local	Restricted					
Amphibians								
Oregon Slender salamander								
Larch Mt. salamander								
Siskiyou Mt. salamander		X		C			** X	2,3a,21-9
Del Norte salamander		*	X	S			** X	2,3a,21-9
Van Dyke's salamander			X	C			** X	2,3a,21-2,21-9
Dunn's salamander		X		S			** X	2,21-2,21-9
Black salamander	X	(x popn.)		C			** X	2,3a,21-9
California slender salamander		X		C			** X	2,3a,21-9
Clouded salamander	X			C			** X	2,21-9
Pacific giant salamander	X			C		X		2,21-9
Cope's giant salamander	X			C			** X	2,3a,14a,21-2,21-9
Olympic salamander	X			C?			** X	2,3a,21-2,21-9
Northwestern salamander		X		S			** X	21-9
Shasta salamander	X			C			** X	2,3a,21-2,21-9
Roughskin newt		X		C		X		2,3a,21-2,21-9
Tailed frog			X	S			** X	21-2
16 amphibian species	X			C			** X	2,3a,3b,21-2,21-9
Reptiles	X			S			** X	2,3a,21-2,21-9

0 reptile species

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Amphibians and Reptiles (continued)

Species	Comments
Amphibians	
Oregon Slender salamander	
Larch Mt. salamander	
Siskiyou Mt. salamander	
Del Norte salamander	
Van Dyke's salamander	Disjunct pops in w. WA and so. ID
Dunn's salamander	rocks, streams, waterfalls (Beatty and Blaustein 1992)
Black salamander	
California slender salamander	
Clouded salamander	
Pacific giant salamander	
Cope's giant salamander	
Olympic salamander	
Northwestern salamander	
Shasta salamander	uses limestone areas
Roughskin newt	OG associate in WA only (Ruggiero et al. 1991)
Tailed frog	
16 amphibian species	
Reptiles	
0 reptile species	

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Birds Part 1

P=Primary; S=Secondary
/=most/less use; ( )=equal use; *=spec. hab. req.

Canopy: <=25% young growth w/ legacies classic old growth

	Breeding, foraging, and resting habitat								Microhabitat				
	Successional stages					Old growth stand structural stages							
	Young		Mid	Late successional									
Species	Grass/forb	Shrub/sap	Pole	Mature	Old growth	Sparse	Comp	Class OG	Talus	Logs	Duff/litt	Lg snags	Lg tree
BIRDS													
Marbled murrelet			S	S	P			X					X
Barrow's goldeneye				P	P			X				X	
Bufflehead				P	P			X				X	
Wood duck				P	P			X		X		X	
Hooded merganser				P	P			X				X	
Common merganser				P	P			X				X	X
Harlequin duck			P	P	P								
Northern goshawk			S	P/S	P/S	X		X					X
Bald eagle	S			S	(PS)	X		X				X	X
Barred owl			S	(PS)	(PS)	X		X				X	
Northern pygmy-owl	S	S	S	P/S	P/S	X		X				X	
Northern spotted owl			S	S	P/S	X		X			\	X	X
Flammulated owl	P	P		P	P	X	X	X			**	X	
Great gray owl				P	P			X				X	X
Vaux's swift	P	P	S	S	P/S	X	X	X				X	X
Pileated woodpecker	S		S	S	P/S	X		X		X		X	X
Hairy woodpecker			S	S	P/S	X		X		X		X	
White-headed woodpecker			S	S	S/P			X				X	
Black-backed woodpecker			S	S/P	(PS)	X		X				X	
Three-toed woodpecker			S	(SP)	P/S	X		X		X		X	
Red-breasted sapsucker			S	S	S	X						X	

Appendix 5-D

Terrestrial Vertebrates ("Short List") - Birds Part 1 (continued)

Species	Dispersal capability: Stand (~<60 ac)	Dispersal capability: Landscape (~<1-5K ac)	Dispersal capability: Range (across provinces)	Lehmkuhl vulner. risk rating	Brown versatil. rating	Migratory or resident (m or r)	Strong riparian assoc.?
BIRDS							
Marbled murrelet				24	6	R/D	X
Barrow's goldeneye				27	9	M/D/R	X
Bufflehead				27	9	M/R	X
Wood duck				27	25	M/R	X
Hooded merganser				27	12	D/M/R	X
Common merganser				27	9	D	X
Harlequin duck					6	M	X
Northern goshawk				26	19	E	
Bald eagle					19	D/R	X
Barred owl					21	R	
Northern pygmy-owl					36	R	
Northern spotted owl				26	12	R	
Flammulated owl						M	
Great gray owl						R	
Vaux's swift				27	34	M	
Pileated woodpecker				27	27	R	
Hairy woodpecker				22	22	R	
White-headed woodpecker					12	E/R	
Black-backed woodpecker					16	R	
Three-toed woodpecker					15	D/M	
Red-breasted sapsucker			X	26	26	D/R	

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Birds Part 1 (continued)

	Presence													
	By state			By physiographic province (from Draft Recovery Plan)										
				Washington				Oregon				California		
Species	WA	OR	CA	OLPE	WACA	WACAE	WA Lowln	ORCAW	ORCAE	OCOR	OR KLAM	CA KLAM	CA Cas	CA Coast
BIRDS														
Marbled murrelet	X	X	X	X	X	X	X			X	X	X		X
Barrow's goldeneye	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bufflehead	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Wood duck	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hooded merganser	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Common merganser	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Harlequin duck	X	X	X	X	X	X	X	X	X	X	X			X
Northern goshawk	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bald eagle	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Barred owl	X	X		?	X	X	X	X	X					
Northern pygmy-owl		X	X	X	X	X	X	X	X	X	X	X	X	X
Northern spotted owl	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Flammulated owl	X	X	X			X		X	X		?	X	X	X
Great grey owl		X						X	X		X			
Vaux's swift	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pileated woodpecker	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hairy woodpecker	X	X	X	X	X	X	X	X	X	X	X	X	X	X
White-headed woodpecker	X	X	X			X		X	X		X	X	X	X
Black-backed woodpecker	X	X	X		X	X		X	X		X	X	X	
Three-toed woodpecker	X	X			X			X						
Red-breasted sapsucker	X	X	X	X	X		X	X	X	X	X	X	X	X

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Birds Part 1 (continued)

Species	Degree of endemism: not really endemic to the range of the NSO	Degree of endemism: is endemic to the range of the NSO	Degree of endemism: very tiny range	General abundance within NSO range (qualit. rank: S = scarce everywhere, C = common somewhere)	Population trend w/in NSO range: Increasing	Stable	Decreasing	References
BIRDS								
Marbled murrelet	X			S			X	2,3,5,7,9,16a,16b,21-10,21-12
Barrow's goldeneye	X			S			X	2,3,5,16a,16b,21-8,21-12
Bufflehead	X			C			?	2,3,5,9,16a,16b,21-8,21-12
Wood duck	X			C			?	2,3,5,16a,16b,21-8,21-12
Hooded merganser	X			S				2,3,5,16a,16b,21-8,21-12
Common merganser	X			C				2,3,16a,16b,21-8,21-12
Harlequin duck	X			S			X	1,2,5,7,9,16a,16b,21-8,21-12
Northern goshawk	X	X'(OLY)		S			X	2,3,6,9,16a,16b,21-8,21-12
Bald eagle	X			S		?		1,2,7,16a,16b,21-1,21-6,21-8,21-12
Barred owl	X			C	X			2,16a,16b,12-8,21-12
Northern pygmy-owl	X			C				2,4,5,9,16a,16b,21-8,21-12
Northern spotted owl	X	X		S			X	2,3,5,16a,16b
Flammulated owl	X			C	Sharp - insufficient data			5,7,9,16a,16b,21-1,21-6,21-12
Great gray owl	X			S			X	5,9,16a,16b,21-1,21-12
Vaux's swift	X			C		X		2,3,4,7,16a,16b,13,21-6,21-8,21-12
Pileated woodpecker	X			S			X	2,3,4,5,7,9,14b,16a,16b,21-1,21-8,21
Hairy woodpecker	X			C			X	2,3,4,14b,16a,16b,21-1,21-8,21-12
White-headed woodpecker	X			S				2,7,9,16a,16b,21-1,21-8,21-12
Black-backed woodpecker	X			S			?	2,9,16a,16b,21-1,21-8,21-12
Three-toed woodpecker	X			S				2,9,16a,16b,21-8
Red-breasted sapsucker	X			C			X	1,2,3a,4,5,14b,16b,21-8,21-12

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Birds Part 1 (continued)

Species	Comments
BIRDS	
Marbled murrelet	
Barrow's goldeneye	
Bufflehead	
Wood duck	
Hooded merganser	
Common merganser	
Harlequin duck	
Northern goshawk	
Bald eagle	
Barred owl	
Northern pygmy-owl	
Northern spotted owl	
Flammulated owl	
Great gray owl	
Vaux's swift	
Pileated woodpecker	
Hairy woodpecker	
White-headed woodpecker	
Black-backed woodpecker	
Three-toed woodpecker	
Red-breasted sapsucker	

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Birds Part 2

P=Primary; S=Secondary
/=most/less use; ( )=equal use; *=spec. hab. req.

Canopy: <=25% young growth w/ legacies classic old growth

	Breeding, foraging, and resting habitat												
	Successional stages					Old growth stand structural stages			Microhabitat				
	Young		Mid	Late successional									
Species	Grass/forb	Shrub/sap	Pole	Mature	Old growth	Sparse	Comp	Class. OG	Talus	Logs	Duff/litt	Lg snags	Lg tree
Williamson's sapsucker			S	S	S	X						X	
Northern flicker	P	S	S	P/S	P/S	X		X		X		X	
Western flycatcher				S	P	X		X					
Hammond's flycatcher			S	(PS)	P			X					X
Chestnut-backed chickadee		S	P	P	P	X	X	X				X	
Brown creeper			S	P/S*	P/S*	X		X				X	
Red-breasted nuthatch			S	P	P	X		X		X		X	
White breasted nuthatch		S	S	P	P	X		X				X	X
Pygmy nuthatch			S	P	P	X		X				X	
Winter wren		P	S	P	P		X	X		X			
Golden-crowned kinglet		S	P/S	P/S	P	X							
Hermit thrush		P	(PS)	P	P/S*	X							
Varied thrush		P	S	P/S*	P/S*	X							
Hermit warbler			P/S	P/S	P/S	X							
Wilson's warbler		P	S	S/P	S/P						"		
Warbling vireo		S/P	S/P	S	P	X							
Red crossbill			S	P/S	P/S	X							

38 bird species

S* = secondary use in subalpine and lodgepole veg types only

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Birds Part 2 (continued)

Species	Dispersal capability: Stand	Dispersal capability: Landscape	Dispersal capability: Range (across provinces)	Lehmkuhl vulner. risk rating	Brown versatil. rating	Migratory or resident (m or r)	Strong riparian assoc.?
Williamson's sapsucker			X		15	D/M	
Northern flicker			X	24	33	R	
Western flycatcher			X		24	M	
Hammond's flycatcher			X	25	26	M	
Chestnut-backed chickadee			X	13	28	R	
Brown creeper			X	19	29	R	
Red-breasted nuthatch			X	19	24	R	
White breasted nuthatch			X		17	R	
Pygmy nuthatch			X		8	R	
Winter wren			X	14	27	D	
Golden-crowned kinglet			X	16	27	R	
Hermit thrush			X	23	30	D/E	
Varied thrush			X	20	28	D/E	
Hermit warbler			X	18	25	M	
Wilson's warbler			X	24	33	M	
Warbling vireo			X		26	M	
Red crossbill			X	23	23	R	

39 bird species

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Birds Part 2 (continued)

	Presence													
	By state			By physiographic province (from Draft Recovery Plan)										
				Washington				Oregon				California		
Species	WA	OR	CA	OLPE	WACA	WACAE	WA Lowln	ORCAW	ORCAE	OCOR	OR KLAM	CA KLAM	CA Cas	CA Coast
Williamson's sapsucker	X	X	X			X			X		X	X	X	
Northern flicker	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Western flycatcher	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hammond's flycatcher	X	X	X	X	X	X	X	X	X			X	X	
Chestnut-backed chickadee	X	X	X	X	X	X	X	X		X	X	X	X	X
Brown creeper	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Red-breasted nuthatch	X	X	X	X	X	X	X	X	X	X	X	X	X	X
White breasted nuthatch	X	X	X		X	X	X	X	X	X	X	X	X	X
Pygmy nuthatch	X	X	X			X			X			X	X	X
Winter wren	*X	X	X	X	X	X	X	X	X	X	X	X	X	X
Golden-crowned kinglet	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hermit thrush	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Varied thrush	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hermit warbler	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Wilson's warbler	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Warbling vireo	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Red crossbill	X	X	X	X	X	X	X	X	X	X	X	X	X	X

36 bird species

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Birds Part 2 (continued)

not really endemic to the range of the NSO

is endemic to the range of the NSO

very tiny range

qualit. rank:
S = scarce everywhere
C = common somewhere

Species	Degree of endem ism			General abundance within	Population trend w/in NSO range			References
	Broad	Local	Restricted	NSO range	Increasing	Stable	Decreasing	
Williamson's sapsucker	X			C		X		2,5,13,21-1,21-8,21-12
Northern flicker	X			C			X	2,3a,3b,4,5,14b,16a,21-8,21-12
Western flycatcher	X			C			X	1,2,4,5,14b,16b,21-8,21-12
Hammond's flycatcher	X			C			X	1,2,3a,4,5,13,14b,21-8,21-12
Chestnut-backed chickadee	X			C			X	1,2,3a,3b,4,5,14b,16a,21-8,21-12
Brown creeper	X			C			X	1,2,3a,4,5,14b,16a,21-8,21-12
Red-breasted nuthatch	X			C			X	1,2,3a,4,5,14b,16a,21-8,21-12
White breasted nuthatch	X			C			X	2,3b,4,5,14b,16a,21-8,21-12
Pygmy nuthatch	X			C				2,5,16a,21-8,21-12
Winter wren	X			C			X	1,2,3a,4,5,14b,16a21-8,21-12
Golden-crowned kinglet	X			C			X	2,3a,3b,4,5,14b,16a,21-8,21-12
Hermit thrush	X			C			X	1,2,3a,4,5,13,14b,21-8,21-12
Varied thrush	X			C				2,3a,3b,4,5,16b,21-8,21-12
Hermit warbler	X			C			X	1,2,3a,4,5,14b,21-8,21-12
Wilson's warbler	X			C		X		1,2,3a,4,5,13,14a,21-8,21-12
Warbling vireo	X			C			X	1,2,4,5,13,14b,16a,21-8,21-12
Red crossbill	X			C			X	2,3a,3b,4,5,14b,16a,21-8,21-12

38 bird species

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Birds Part 2 (continued)

Species	Comments
Williamson's sapsucker	
Northern flicker	assoc'd w/ open forests
Western flycatcher	incr. assoc'n with stand age (Marcot 1985)
Hammond's flycatcher	
Chestnut-backed chickadee	incr. assoc'n with stand age (Marcot 1985)
Brown creeper	
Red-breasted nuthatch	+/- equal use pole & med sawt stages (Marcot 1985)
White breasted nuthatch	
Pygmy nuthatch	
Winter wren	shifts to late shrub stage in fall (Marcot 1985)
Golden-crowned kinglet	
Hermit thrush	
Varied thrush	
Hermit warbler	
Wilson's warbler	
Warbling vireo	
Red crossbill	

38 bird species

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Mammals Part 1

P=Primary; S=Secondary
/=most/less use; ( )=equal use; *=spec. hab. req.

Canopy: <=25%; young growth w/ legacies; classic old growth

	Breeding, foraging, and resting habitat												
	Successional stages					Old growth stand structural stages			Microhabitat				
	Young		Mid	Late successional									
Species	Grass/forb	Shrub/sap	Pole	Mature	Old growth	Sparse	Comp	Class. OG	Talus	Logs	Duff/litt	Lg snags	Lg tree
MAMMALS													
Marten			S	P	P			X		X		X	X
Fisher			S	P	P	X		X	X	X		X	X
Dusky-footed woodrat		P	P	P	P	X	X	X		X	X		
Northern flying squirrel			S	P	P	X		X		X		X	X
Douglas squirrel		P	P	P	P	X	X	X		X		X	X
Townsend's chipmunk	S	S	P/S	P/S	P/S		X	X	X	X			
Red tree vole (P.longicaudus)			(PS)	S/P	S/P	X	X	X			X		X
Red tree vole (P.pomo)											X		X
Western red-backed vole			P	P	P	X	X	X		X	X	X	
Southern red-backed vole			P	P	P		X	X	X	X			
Forest deer mouse				P	P			X		X			
Deer mouse	S	P	(PS)	S	S	X	X		X	X	X	X	
Pacific shrew	S	P/S	S	S	S	X	X			X	X		
Shrew-mole	S	S	S/P	P/S	S/P		X	X		X	X		
Big brown bat	P/S		S	S/P	P/S	X		X				X	
Silver- haired bat	P		P	S/P	P/S	X	X	X				X	
Hoary bat		P	P	P/S	P/S	X	X	X					X
Long-legged myotis	S	P	S/P	P/S	P/S		X	X				X	X
Yuma myotis	P	P	S/P	P	P		X	X				X	
California myotis	P/S	S/P	P	P/S	S/P	X	X	X		X		X	X
Keen's myotis	P/S	P/S	S	S/P	S/P		X	X				X	

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Mammals Part 1 (continued)

Species	Dispersal capability: ~<60 ac (Stand)	Dispersal capability: ~<1-5K ac (Landscape)	Dispersal capability: across provinces (Range)	Lehmkuhl vulner. risk rating	Brown versatil. rating	Migratory or resident (m or r)	Strong riparian assoc.?
MAMMALS							
Marten			X	26	23	R	X
Fisher			X	26	23	R	
Dusky-footed woodrat		?			28		?(rec plan)
Northern flying squirrel		?		28	26	R	
Douglas squirrel		?		28	26	R	
Townsend's chipmunk	X				32	R	
Red tree vole (P.longicaudus)	X			28	14	R	
Red tree vole (P.pomo)	X						
Western red-backed vole	X			21	16	R	
Southern red-backed vole	X			18	19	R	
Forest deer mouse	X			27		R	
Deer mouse	X				42	R	
Pacific shrew	X			28	28	R	X
Shrew-mole	X			226	34	R	X
Big brown bat			?	25	33	R	X
Silver- haired bat			?	25	28	M/R	
Hoary bat			?		25	M	X
Long-legged myotis			?	25	32	M/R	X
Yuma myotis			?	25	30	?	Feeding
California myotis			?	25	27	R	
Keen's myotis		?		25	21	?	Feeding

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Mammals Part 1 (continued)

	Presence													
	By state			By physiographic province (from Draft Recovery Plan)										
				Washington				Oregon				California		
Species	WA	OR	CA	OLPE	WACA	WACAE	WA Lowln	ORCAW	ORCAE	OCOR	OR KLAM	CA KLAM	CA Cas	CA Coast
MAMMALS														
Marten	X	X	X	X	X	X	X	X	X	X	X	X		
Fisher	X	X	X	X	X	X		X	X	X	X	X		X
Dusky-footed woodrat		X	X					X		X	X	X	X	X
Northern flying squirrel	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Douglas squirrel	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Townsend's chipmunk	X	X		X	X	X	X	X	X	X	X			
Red tree vole (P.longicaudus)		X						X	X	X	X			
Red tree vole (P.pomo)			X								X		X	
Western red-backed vole		X	X					X	X	X	X	X	X	
Southern red-backed vole	X			X	X	X	X							
Forest deer mouse	X			X	X	X	X							
Deer mouse	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pacific shrew		X	X							X	X	X	X	X
Shrew-mole	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Big brown bat	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Silver- haired bat	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hoary bat	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Long-legged myotis	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Yuma myotis	X	X	X	X	X	X	X	X	X	X	X	X	X	X
California myotis	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Keen's myotis	X			X			X							

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Mammals Part 1 (continued)

not really endemic to the range of the NSO

is endemic to the range of the NSO

very tiny range

qualit. rank
S = scarce everywhere
C = common somewhere

Species	Degree of endemism: Broad	Local	Restricted	General abundance within NSO range	Population trend w/in NSO range: Increasing	Stable	Decreasing	References
MAMMALS								
Marten	X			S			X	1,2,3a,5,21-1,21-11
Fisher	X			S			X	2,3a,5,21-1,21-11
Dusky-footed woodrat	X			C				1,2,3a,5,21-3,21-4,21-11
Northern flying squirrel	X			C				1,2,3a,5,21-3,21-11
Douglas squirrel	X			C				2,3a,5,21-3,21-5,21-11
Townsend's chipmunk		X		C				1,2,3a,5,21-4,21-5,21-11
Red tree vole (P.longicaudus)		X		S				1,2,3a,5,11a,21-4
Red tree vole (P.pomo)	X							1,2,5,21-11
Western red-backed vole		X		C				1,2,3a,5,19,21-4,21-11
Southern red-backed vole		X						1,2,3a,5,21-5
Forest deer mouse	X							1,2,3a,3b,21-5
Deer mouse	X			C				2,3a,5,21-3,21-5,21-11
Pacific shrew	X			C				2,3a,5,21-4,21-11
Shrew-mole	X							1,2,3a,5,21-3,21-5,21-11
Big brown bat	X			C				2,3a,5,21-3,21-11
Silver- haired bat	X							2,5,11c,21-3,21-5,21-11
Hoary bat	X			C				2,5,21-3,21-11
Long-legged myotis	X			C				2,3a,5,21-3,21-5,21-11
Yuma myotis	X			C				2,3a,5,19,21-3,21-11
California myotis	X			C				1,2,3a,5,19,21-3,21-11
Keen's myotis		X						2,3a,21-5

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Mammals Part 1 (continued)

Species	Comments
MAMMALS	
Marten	
Fisher	
Dusky-footed woodrat	
Northern flying squirrel	
Douglas squirrel	
Townsend's chipmunk	
Red tree vole (P.longicaudus)	
Red tree vole (P.pomo)	little data available on habitat needs
Western red-backed vole	
Southern red-backed vole	
Forest deer mouse	
Deer mouse	
Pacific shrew	
Shrew-mole	
Big brown bat	
Silver- haired bat	
Hoary bat	
Long-legged myotis	
Yuma myotis	
California myotis	
Keen's myotis	

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Mammals Part 2

P=Primary; S=Secondary
/=most/less use; ( )=equal use; *=spec. hab. req

Canopy <=25%; young growth w/ legacies; classic old growth

Species	Breeding, foraging, and resting habitat: Successional stages: Young: Grass/forb	Young: Shrub/sap	Mid: Pole	Late successional: Mature	Late successional: Old growth	Old growth stand structural stages: Sparse	Comp	Class. OG	Microhabitat: Talus	Logs	Duff/litt	Lg snags	Lg tree
Long-eared myotis		S	S/P	(PS)	P/S	Feeding	X	X				X	X
Fringed myotis	P	P	S	S	S	Feeding							
Little brown myotis	P	P	S/P	(PS)	P/S	X	X	X		X		X	
Lynx	P	P	P/S	P/S	P/S								
Elk	P/S	P/S	P/S	(PS)	(PS)	X							

26 mammal species

Species	Dispersal capability: Stand	Landscape	across provinces: Range	Lehmkuhl vulner. risk rating	Brown versatil. rating	Migratory or resident (m or r)	Strong riparian assoc.?
Long-eared myotis			?	25	30	R	Feeding
Fringed myotis			?	25	30	?	Feeding
Little brown myotis			?	25	34	R	Feeding
Lynx			X		21	R	
Elk			X	*28	32	M	

26 mammal species

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Mammals Part 2 (continued)

	Presence													
	By state			By physiographic province (from Draft Recovery Plan)										
				Washington				Oregon				California		
Species	WA	OR	CA	OLPE	WACA	WACAE	WA Lowln	ORCAW	ORCAE	OCOR	OR KLAM	CA KLAM	CA Cas	CA Coast
Long-eared myotis	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fringed myotis	X	X	X		X	X		X	X	X	X	X	X	X
Little brown myotis	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lynx	X					X								
Elk	X	X	X	X	X	X	X	X	X	X	X	X	X	X

26 mammal species

not really endemic to the range of the NSO

is endemic to the range of the NSO

very tiny range

qualit. rank
S = scarce everywhere
C = common somewhere

	Degree of endemism			General abundance within	Population trend w/in NSO range			
Species	Broad	Local	Restricted	NSO range	Increasing	Stable	Decreasing	References
Long-eared myotis	X			S				2,3a,5,19,21-3,21-5,21-11
Fringed myotis	X			C				2,3a,5,21-3,21-5,21-11
Little brown myotis	X			C				2,3a,5,21-3,21-11
Lynx	X			S				2,20,21-6
Elk	X			C				2,3a,21-4,21-5,21-11

26 mammal species

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Mammals Part 2 (continued)

Species	Comments
Long-eared myotis	
Fringed myotis	
Little brown myotis	
Lynx	
Elk	

26 mammal species

Appendix 5-D
Attributes of Terrestrial Vertebrates

Key to Information on Habitat Attributes Database

Breeding, Resting, and Foraging Habitat

Successional stages - Reference 2 was the primary source of information. Information on various species was also provided by 3b, 7, 8, 9, 11a, 11b, 11c and 20.

Only vegetative communities used by northern spotted owls were assessed for use by each species for breeding, resting, and foraging. Those vegetative communities include: conifer hardwood, mixed conifer forest (southwest Oregon), temperate conifer forest, high temperate coniferous forest, subalpine forest parks and lodgepole pine (Cascades). Subalpine forest and lodgepole are only considered as dispersal habitat for northern spotted owls. Within this section the following codes denote the combined use of vegetative communities and successional stages for breeding, resting, and foraging of species.

P = Primary use of the successional stage for breeding, resting, and foraging by the species.
S = Secondary use of the successional stage for breeding, resting, and foraging by the species.
P/S = A combination of primary and secondary use of the successional stage, with disproportionately more primary use than secondary use by the species.
S/P = A combination of primary and secondary use of the successional stage, with disproportionately more secondary use than primary use by the species.
(PS) = A combination of primary and secondary use of the successional stage, with approximately half the use being primary and half being secondary by the species.

Young - Grass/forb = shrubs less than 40 percent crown cover and less than 5 feet tall; unit may range from mainly devoid of vegetation to dominance by herbaceous species (grasses and forbs); tree regeneration generally less than 5 feet tall and 40 percent crown cover.

Young - Shrub/sap = Shrubs greater than 40 percent crown canopy; average stand diameter greater than 1 inch dbh and tree canopy closure less than 60 percent; saplings are 1 to 4 inches dbh; poles 4 to 9 inches dbh.

Pole = Average stand diameters between 1 and 21 inches dbh and crown cover exceeding 60 percent.

Appendix 5-D
Attributes of Terrestrial Vertebrates

Key to Information on Habitat Attributes Database (continued)

> **Late successional - Mature** = Stand with average diameters exceeding 21 inches in dbh; crown cover may be less than 100 percent, decay and decadence required for old growth may be lacking, and dead and down material required by old growth is lacking.
>
> **Late successional - Old growth** = Stands over 200 years old with at least two tree layers (overstory and understory), decay in living trees, snags, and down woody material. Some of the overstory layer may be composed of long-lived successional species (that is, Douglas-fir, western redcedar).

Stand structure - Reference 5 computer database was the primary source document for sparse structure types. Components and Classic OG were calculated from other attribute columns as explained below.

> **Sparse** = An "X" denotes that the species' use of habitatypes with sparse canopy closure (less than 25 percent) was Moderate to High.
>
> **Components** = primarily young growth with legacy components of older successional stages (i.e., down logs, large trees and snags). An "X" in this column denotes the primary use of shrub/sap or pole successional stages and the use of at least one of the four microhabitat components listed below (down logs, duff/litter, large snags, large trees).
>
> **Classic OG** = classic old-growth forest with multistory and multispecies stands and a high decadence component. An "X" in this column denotes the primary use of old growth successional stage and the use of at least one of the four microhabitat components listed below.

Dispersal habitat = No primary information source documents were identified. This column is a description of habitat used by species for juvenile dispersal from natal areas, and adult dispersal from occupied habitats.

Microhabitat - References used were 2, 5, 7, 8, 9, and 19. Other sources included lla, lib, 11c and 20. An "X" denotes a close association (primary use) by the species with the specified habitat component (**talus, down logs, duff/lltter, large snags, and large trees**).

Dispersal capability - No primary source documents were identified. An "X" in one of the following columns denotes the capability of juveniles and'adults to disperse from natal and occupied habitat.

> **Stand** = species will generally disperse in less than about a 60 acre area.
>
> **Landscape** = species will generally disperse within approximately 60 acres to 5000 acres (subwatershed).

Appendix 5-D
Attributes of Terrestrial Vertebrates

Key to Information on Habitat Attributes Database (continued)

Range = species has the capability to disperse across physiographic province boundaries.

Lehmkuhl vulnerability rating - Reference 3a was used. The rating is a risk rating of local extinction of species. The higher the rating value the higher the risk of local extinction. Risk score = 3 * (frequency + abundance) + 2 * (body size + vagility) + migratory status + variance in abundance. Scores for frequency, abundance and variation were assessed from data presented by Lehmkuhl and others. Total risk was calculated as the weighted sum.

Brown versatility rating - Reference 2. The rating is the sum of the number of plant communities and successional stages used for breeding plus the number of plants communities and successional stages used for feeding by a species. The higher the rating the higher the versatility of the species to use different vegetation communities.

Migratory Status - References 4, 11c, 16a, and 16b were used. Below are codes used to denote migratory status. More than one code was used for species which are known or suspected to have mixed migratory habits.

R = yearlong residents and nomads
M = latitudinal migrants including neot'ropical, lower-latitude nearctic, and high latitude nearctic migrants
D = displacement migrants
E = elevational migrants including seasonal downslope and upslope movements

Riparian Assoc. - References 1, 2, and 7 were used. An "X" denotes a strong riparian association for that species.

State and Physiographic province - Individual species range maps, which were derived from references 21-1 through 21-12 were used. An "X" denotes presence of the species in the state or province.

Degree of endemism - References 1, 3b, 16a, 16b, 16c and 18 along with individual species range maps, which were derived from reference 21-1 through 21-12, were used. An "X" in one of the following columns denotes the geographic range of the species as it relates to the range of the northern spotted owl.

Broad = geographic range extends beyond the range of the northern spotted owl (that is, not strictly endemic within the owl's range).

Local = geographic range does not extend beyond the range of the northern spotted owl but is fairly broad throughout at least one physiographic province therein.

Appendix 5-D
Attributes of Terrestrial Vertebrates

Key to Information on Habitat Attributes Database (continued)

> **Restricted** = geographic range is restricted to a small portion of the northern spotted owls' range, that is, occurs within a small portion of one or only a few physiographic provinces therein,

General abundance - References 13, 16a, 16b were used. Codes denote the general abundance of species throughout the range of the northern spotted owl.

> S = scarce everywhere within the range of the northern spotted owl.
> C = common in at least some areas within the range of the northern spotted owl.

Population trend - References 7, 9, 13, 14a, and 14b were used. Population trend of amphibians was based on trend in their preferred (macro)habitat.

References - References for information summarized in this data table are coded as listed below.

1 USDI. 1992. Recovery plan for the northern spotted owl - draft, appendix D. Portland, OR: U.S. Department of the Interior. 662 p.

2 Brown, E.R., tech. ed. 1985. Management of wildlife and fish habitats in forests of western Oregon and Washington. Portland, OR: USDA Forest Service, Pacific Northwest Region. Vol 2.

3a Lehmkuld, J.F.; Ruggiero, L.F. 1991. Forest fragmentation in the Pacific Northwest and its Potential effects on wildlife. In: Wildlife and vegetation of unmanaged Douglas-fir forests. PNW-GTR-285. Portland, OR: USDA Forest Service, Pacific Northwest Region. 45-46 p.

3b Ruggiero, L.F. 1991. Wildlife habitat relationships and viable populations. In: Wildlife and vegetation of unmanaged Douglas-fir forests. PNW-GTR-285. Portland, OR: USDA Forest Service, Pacific Northwest Region. 456-462 p.

4 Marcot, B.G. 1984. Habitat relationships of birds and young-growth Douglas-fir in northwestern California. 161 & 233-234 p. Ph.D. dissertation.

5 Zeiner, D.C.; Laudenslayer, W.R., Jr.; Mayer, K.E.; White, M., eds. 1988. California's wildlife. Sacramento, CA: California Department of Forestry and Fire Protection. 166 p. 3 additional vol. 1 computer disk.

Vol I, Amphibians and reptiles. 1988.
Vol II, Birds. 1990.
Vol III, Mammals. 1990.
California Department of Fish and Game Wildlife Habitat Relationship System computer database; species sort by specified habitats

Appendix 5-D
Attributes of Terrestrial Vertebrates

Key to Information on Habitat Attributes Database (continued)

7 Rodrick, E.; Milner R., tech. eds. 1991. Management recommendations for Washington's priority habitats and species. Olympia, WA: Washington Department of Wildlife. 206 p.

8 Beatty, J.J.; Blaustein, A.R.; Storm, R.M. 1992. A report to the northern spotted owl recovery team (subgroup addressing other species and older forest ecosystems, Robert G. Anthony, Chairperson): the biology of amphibians and reptiles. Corvallis, OR: Oregon State University. 86 p.

9 Marshall, D. 1992. Sensitive vertebrates of Oregon. Portland, OR: Oregon Department of Fish and Wildlife. 226 p.

11a Huff, M.H.; Holthausen, R.S.; Aubry, K.B. 1992. Habitat management for red tree voles in Douglas-fir forests. PNW-GTR-302. Portland, OR: USDA Forest Service, Pacific Northwest Region. 22 p.

11b Carey, A.B. 1991. The biology of arboreal rodents in Douglas-fir forests. PNW-GTR-276. Olympia, WA: USDA Forest Service, Pacific Northwest Region. 53 p.

11c Christy, R.E.; West, S.D. [In press]. Biology of bats in Douglas-fir forests. PNW-GTR. Portland, OR: USDA Forest Service, Pacific Northwest Region. 64 p.

13 Sharp, B.E. 1992. Neotropical migrants on National Forest in the Pacific Northwest: a compilation of existing information. Portland, OR: Ecological Perspectives. 847 p.

14a Raphael, M.G. 1988. Long-term trends in amphibians, reptiles, and mammals in Douglas-fir forests of northwestern California. Management of amphibians, reptiles, and small mammals in North America: Proceedings of a symposium; 1988 July 19-21; Flagstaff, AZ. GTR-RM-166. Ft. Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 23-31 p.

14b Raphael, M.G.; Rosenburg, K.V.; Marcot, B.G. 1988. Large-scale changes in bird populations of Douglas-fir forests, northwestern California. In: Jackson J.A., ed. Bird conservation. Madison, WI: University of Wisconsin Press, Ltd. 63-83 p.

16a Robbins, C.S.; Bertel, B.; Zim, H.S. 1966. A guide to field identification: birds of North America. Racine, WI: Golden Press New York. 344 p.

I6b National Geographic Society. 1983. Field guide to the birds of North America. Washington, DC: National Geographic Society. 465 p.

Appendix 5-D
Attributes of Terrestrial Vertebrates

Key to Information on Habitat Attributes Database (continued)

16c Ehrlich, P.R.; Dobkin, D.S.; Wheye, D. 1988. The birder's handbook: a field guide to the natural history of North America birds. New York, NY: Simon and Schuster, Fireside.

18 Ingles, L.G. 1976. Mammals of the Pacific states: California, Oregon, Washington. Stanford, CA: Stanford University Press. 520 p.

19 Verner, J.; Boss, A.S. tech. coords. 1980. California wildlife and their habitats: western Sierra Nevada. GTR-PSW-37. Berkeley, CA: USDA Forest Service, Pacific Southwest Forest and Range Experiment Station. 443 p.

20 Butts, T.W. 1992, Lynx (Felix lynx) biology and management. A literature review and annotated bibliography. Missoula, MT: USDA Forest Service, Northern Region. 268 p.

The following references were used to develop the individual species range maps:

21-1 Marshall, D.B. 1992. Threatened and sensitive wildlife of Oregon's forests and woodlands. Portland, OR: Audubon Society of Portland: 66 p.

21-2 Zeiner, D.C.; Laudenslayer, W.P., Jr.; Mayer, K.E., eds. 1988. California's wildlife. Vol. I - Amphibians and reptiles. Sacramento, CA: California Department of Fish and Game. 272 p.

21-3 Ingles, L.G. 1965. Mammals of the Pacific states: California, Oregon, and Washington. Stanford, CA: Stanford University Press. 506 p.

21-4 Maser, C.; Mate, B.R.; Franklin, J.F.; Dyrness, C.T. 1981. Natural history of Oregon Coast mammals. Gen. Tech. Rep. PNW-133. Portland, OR: USDA Forest Service.

21-5 Dalquest, W.W. 1948. Mammals of Washington. Vol. 2. Lawrence, KS: University of Kansas. 144 p.

21-6 Rodrick, E.; Milner, R., tech. eds. 1991. Management recommendations for Washington's priority habitats and species. Olympia, WA: Washington Department of Wildlife. 189 p.

21-7 Hall, E.R.; Kelson, K.R. 1959. The mammals of North America, Vol. II. New York, NY: The Ronald Press.

21-8 Peterson, R.T. 1990. A field guide to western birds. Third edition. Boston, MA: Houghton Mifflin Co. 432 p.

Appendix 5-D
Attributes of Terrestrial Vertebrates

Key to Information on Habitat Attributes Database (continued)

21-9 Leonard, W.; Brown, H.; Jones, L., [and others]. [In press]. Amphibians of Washington and Oregon. Seattle, WA: Audubon Society. 30 p.

21-10 USDI Fish and Wildlife Service. Data via Oregon State Center for GIS.

21-11 Zeiner, D.C.; Laudenslayer, W.F., Jr.; Mayer, K.E.; White M., eds. 1990. California's wildlife. Vol. III - Mammals. Sacramento, CA: California Department of Fish and Game. 407 p.

21-12 Zeiner, D.C.; Laudenslayer, W.F., Jr.; Mayer, K.E.; White M., eds. 1990. California's wildlife. Vol. II - Birds. Sacramento, CA: California Department of Fish and Game. 731 p.

Appendix 5-E

List of Expert Viability Panel Participants

Appendix 5-E
List of Expert Viability Panel Participants

Nonvascular Plants

Robin Lesher	Panel Leader, Forest Service, Mt. Baker-Snoqualmie National Forest, Mountlake Terrace, Washington
Joseph Ammirati	University of Washington, Department of Biology, Seattle, Washington
John Cristy	Oregon Natural Heritage Program, Portland, Oregon
William Denison	Oregon State University, Department of Botany and Plant Pathology, Corvallis, Oregon
Daniel Norris	Oregon State University, Department of Botany and Plant Pathology, Corvallis, Oregon

Vascular Plants

Joan Ziegltrum	Panel leader, Forest Service, Olympic National Forest, Olympia, Washington
Kenneth Berg	California Department of Fish and Game, Sacramento, California
Bruce Bingham	Forest Service, Pacific Southwest Forest and Range Experiment Station, Redwood Sciences Laboratory, Arcata, California
Rex Crawford	Washington Natural Heritage Program, Olympia, Washington
Lisa McCrimmon	Forest Service, Siskiyou National Forest, Grants Pass, Oregon
David Peter	Forest Service, Mt. Baker-Snoqualmie National Forest, Mountlake Terrace, Washington
Steven Rust	Forest Service, Wenatchee National Forest, Wenatchee National Forest

Invertebrates

Review was contracted with:	
David Olson	The Xerces Society, Portland, Oregon
Ingrith Deyrup-Olsen	University of Washington, Department of Zoology, Seattle, Washington

Appendix 5-E
List of Expert Viability Panel Participants (continued)

Fish

Gordon H. Reeves	Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Corvallis, Oregon
James R. Sedell	Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Corvallis, Oregon

Amphibians and Reptiles

Martin G. Raphael	Panel leader, Forest Service, Pacific Northwest Research Station, Forestry Science Laboratory, Olympia, Washington
Keith Aubry	Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Olympia, Washington
Andrew Blaustein	Oregon State University, Department of Zoology, Corvallis, Oregon
John Brode	California Department of Fish and Game, inland Fisheries Division, Rancho Cordova, California
R. Bruce Bury	USDI Fish and Wildlife Service, National Ecology Research Center, Fort Collins, Colorado
P. Stephen Corn	USDI Fish and Wildlife Service, National Ecology Research Center, Fort Collins, Colorado
Lawrence C. Jones	Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Olympia, Washington
HartweU Welsh	Forest Service, Pacific Southwest Forest and Range Experiment Station, Redwood Sciences Laboratory, Arcata, California

Birds

Bruce G. Marcot	Panel Leader, Forest Service, Pacific Northwest Research Station, Portland, Oregon
Andrew Hanson	Oregon State University, Forestry Sciences Department, Corvallis, Oregon
Mark Huff	Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Olympia, Washington

Appendix 5-E
List of Expert Viability Panel Participants (continued)

David Manuwal	University of Washington, College of Forest Resources, Seattle, Washington
David Marshall	Consultant, Portland, Oregon
Kevin McGarigal	Oregon State University, Forestry Sciences Department, Corvallis, Oregon
Kimberly Nelson	Oregon State University, Cooperative Research Unit, Department of Fish and Wildlife, Corvallis, Oregon
Mammals	
Robert G. Anthony	Panel leader, Oregon State University, Cooperative Research Unit, Department of Fish and Wildlife, Corvallis, Oregon
Andrew Carey	Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Olympia, Washington
Stephen Cross	Southern Oregon State College, Department of Biology, Ashland, Oregon
Fredrick F. Gilbert	University of Northern British Columbia, Dean of Natural Resources/Environmental Studies, Prince George, British Columbia
James Hallot	Washington State University, Department of Zoology, Pullman, Washington
Christine McGuire	Western Washington University, Huxely College, Bellingham, Washington
Cynthia Zabel	Forest Service, Pacific Southwest Forest and Range Experiment Station, Redwood Sciences Laboratory, Arcata, California

Appendix 5-F

Invertebrate Species Closely Associated With Old-Growth Forests in National Forests Within the Range of the Northern Spotted Owl

Key to status codes and references appear at the end of this appendix.

Appendix 5-F
Invertebrate Species - Class Diplopoda

OG forest assoc.	Ripar. assoc.	Fed. status	Reference FWS	Reference Ols	Common name
Phylum Arthropoda					
Class Diplopoda (millipedes)					
Order Chordeumatida					
Family Caseyidae					
Caseya benedictae	1				1
Caseya briophila	1				1
Caseya bucketti	1				1
Caseya longiloba	1				1
Caseya megasoma	1				1
Caseya megasoma	1				1
Caseya shastaensis	1				1
Harpaphe haydeniana	1			1	
Metopiona sheari	1				1
Ochrogramma heterogona	1				1
Ochrogramma formulosa	1				1
Ochrogramma haigi	1				1
Opiona bifurcata	1				1
Opiona casualis	1				1
Opiona communis angusta	1				1
Opiona confusa	1				1
Opiona distincta	1				1
Opiona exigua	1				1
Opiona facetia	1				1
Opiona fisheri	1				1
Opiona goedeni	1				1
Opiona scytonotoides	1				1
Opiona siliquae	1				1
Tuhaphe levii	1				1
TOTAL DIPLOPODA:	24	0			

Appendix 5-F
Invertebrate Species - Class Arachnida

Scientific name	OG forest assoc.	Ripar. assoc.	Fed. status	Reference FWS	Reference Ols	Common name
Class Arachnida						
Order Araneida (spiders)						
Family Agelenidae						
Cybaeina minuta	1				1	
Order Phalangida (harvestman)						
Cryptomaster leviathan	1				1	
Isoiachus spinosus	1				1	
Pentanychus hamatus	1				1	
Pentanchyus clavatus	1				1	
Pentanchyus bilobatus	1				1	
Pentanchyus flavescens	1				1	
Pentanchyus pacificus	1				1	
TOTAL ARACHNIDA:	8	0				

Appendix 5-F
Invertebrate Species - Class Insecta

	OG forest assoc.	Ripar. assoc.	Fed. status	Reference FWS	Reference Ols	Common name
Class Insecta (Insects)						
Order Orthoptera						
Boonacris alticola	1			1		
Pristoceuthophilus celatus	1			1		
Pristoceuthophilus cercalis	1			1		
Pristoceuthophilus sargentae	1			1		
Tropidischia xanthostoma	1			1		
Order Hemiptera						
Boreostolis americanus	1			1		
Plinthisus longisetosus	1			1		
Thylochromus nitidulus	1			1		
Eurychilopterella sp.	1			1		
Phytocoris nobilis	1			1		
Pithanus maerkelii	1			1		
Polymerus castellaeni	1			1		
Vanduzeenia borealis	1			1		
Acalypta lillianis	1			1		
Acalypta saundersi	1			1		
Derephysia foliacea	1			1		
Order Coleoptera						
Pterecus humboldti	1				1	
Cychrus tuberculatus	1			1		
Metrius contractus	1			1		
Promecognathus laevissimus	1			1		
Zacotus mathewsii	1			1		
Omus dejeani	1			1		
Lobosoma horridum	1			1		
Acneus beeri		1	C2	1		
Acneus burnelli			C2	1		
Cicindela columbica		1		1		
Pterostichus rothi	1			1		
Order Plecoptera						
Nemoura wahkeena		1	C2	1		
Solperia fenderi		1	C2	1		
Order Trichoptera						
Eobrachycentrus gelidae		1	C2	1		
Agapetus denningi		1	C2	1		
Homoplecta schuhi		1	C2	1		
Ochrotrichia alsea		1	C2	1		
Lepidostoma goedeni		1	C2	1		
Apatania tavaia		1	C2	1		
Farula davisi		1	C2	1		
Farula jewetti		1	C2	1		

Appendix 5-F
Invertebrate Species - Class Insecta (continued)

	OG forest assoc.	Ripar. assoc.	Fed. status	Reference FWS	Reference Ols	Common name
Farula reaperi		1	C2	1		
Limnephilus alconura		1	C2	1		
Limnephilus atereus		1	C2	1		
Neothremma andersoni		1	C2	1		
Oligophlebodes mostbento		1	C2	1		
Philocasca oron		1	C2	1		
Dolophilodes oregona		1	C2	1		
Tinodes siskyou		1	C2	1		
Rhyacophila ambilis		1	C2	1		
Rhyacophila colonus		1	C2	1		
Rhyacophila fenderi		1	C2	1		
Rhyacophila haddocki		1	C2	1		
Rhyacophila lineata		1	C2	1		
Rhyacophila mosana		1	C2	1		
Rhyacophila unipunctata		1	C2	1		
Desmona bethula		1	C2	1		
Cryptochia shasta		1	C2	1		
Goeracea oregona		1	C1	1		
Neothremma genella		1	C2	1		
Neothremma siskyou		1	C2	1		
Ochrotrichia vertreesi		1	C2	1		
Abellan hydropsyche		1	C2	1		
TOTAL INSECTA:	*24*	*34*				

Appendix 5-F
Invertebrate Species - Class Mollusca

	OG forest assoc.	Ripar. assoc.	Fed. status	Reference FWS	Reference Ols	Common name
Phylum Mollusca						
Fluminicola columbiana		1	C2	1		Columbia pebblesnail
Fisherola nuttalli nuttalli			C3	1		Shortface lanx
Monadenia fidelis minor			C2	1		Dalles sideband
Monadenia troglodytes chaceana	1	1	C2	1		No common name
Monadenia troglodytes troglodytes	1	1	C2	1		Shasta sideband
Monadenia troglodytes wintu	1	1	C2	1		Wintu sideband
Monadenia fidelis pronotis		1	C2	1		Rocky coast sideband
Monadenia setosa	1	1	C2	1		Trinity bristlesnail
Vespericola karokorum	1	1	C1	1		Karok hesperian
Juga hemphilli hemphilli	1	1		1		Barren juga
Juga hemphilli dallesensis	1	1		1		Dalles juga
Juga hemphilli subsp.	1	1		1		No common name
Juga (J.) n. sp. 1	1	1		1		Brown juga
Juga (J.) n. sp. 3	1	1		1		Tall juga
Juga (O.) n. sp. 1		1		1		No common name
Juga (O.) n. sp. 2		1		1		No common name
Juga (C.) actitilosa	1	1		1		Scalloped juga
Juga (C.) occata		1		1		Topaz juga
Amnicola (L.) n. sp.	1	1		1		No common name
Vorticifex neritoides				1		Nerite rams-horn
Physella columbiana				1		Rotund physa
Fluminicola seminalis	1	1		1		Vagrant pebblesnail
Lanx alta	1			1		Highcap lanx
Lanx patelloides				1		Kneecap lanx
Helisoma newberryi newberryi		1		1		Great Basin rams-horn
Vespericola columbiana columbiana				1		Columbia hesperian
Hemphillia malonei	1	1		1		Malone jumping-slug
Hemphillia pantherina	1	1		1		Panther jumping-slug
Hemphillia glandulosa glandulosa	1	1		1		Warty jumping-slug
Hemphillia barringtoni	1	1		1		Burrington jumping-slug
Prophysaon coeruleum	1	1		1		Blue-gray tail-dropper
Prophysaon dubium	1	1		1		Papillose tail-dropper
Monodenia fidelis columbiana	1	1		1		Columbia sideband
Monadenia fidelis beryllica	1	1		1		Green sideband
Monadenia fiddelis celeuthia	1	1		1		Traveling sideband
Monadenia fidelis ochromphalous	1	1		1		Yellow-base sideband
Monadenia fidelis leonina	1	1		1		Tawny sideband
Monadenia fidelis klamathica	1	1		1		No common name
Monadenia churchi	1	1		1		Klamath sideband
Trilobopsis roperi	1	1		1		Shasta chaparral
Trilobasis tehamana	1	1		1		Tehama chaparral

Appendix 5-F
Invertebrate Species - Class Mollusca (continued)

	OG forest assoc.	Ripar. assoc.	Fed. status	Reference FWS	Reference Ols	Common name
Vespericola shasta	1	1		1		Shasta hesperian
Vespericola sierrana	1	1		1		Siskyou hesperian
Vespericola megasoma euthales	1	1		1		Large hesperian
Megomphix hemphilli	1	1		1		Oregon megomphix
Anodonta wahlametensis				1		Willamette floater
Juga (Oreobasis) chacei	1	1		1		No common name
Juga (Oreobasis) orickensis	1	1		1		No common name
Lanx subrotundata	1			1		Rotund lanx
Monadenia callipeplus	1	1		1		No common name
Monadenia cristulata	1	?		1		No common name
Monadenia fidelis salmonensis	1	1		1		No common name
Monadenia fidelis scottiana	1	?		1		No common name
Monadenia rotifera	1	?		1		No common name
Haplotrema voyanum	1	?		1		Hooded lancetooth
Helminthoglypta hertleini		1		1		Oregon shoulderband
Deroceras hesperium	1	1		1		Evening fieldslug
Anodonta californiensis		1	C2	1		California floater

TOTAL MOLLUSCA:	*43*	*45*

TOTALS BY CLASS AND HABITAT

DIPLOPODA	24	0
ARACHNIDA	8	0
INSECTA	24	34
MOLLUSCA	43	45

GRAND TOTAL	99	79

TOTALS BY CLASS:

ARTHROPODS	91
MOLLUSCS	58
ALL	149

Appendix 5-F
Invertebrate Species

Federal Status: E = endangered, T = threatened, C = candidate

OG = Old Growth

References

FWS = USDI. 1992. Recovery plan for the northern spotted owl - draft. Portland, OR: U.S. Department of the Interior. 662 p.

OLS = Olson, David M. 1992. The northern spotted owl conservation strategy: implications for Pacific Northwest forest invertebrates and associated ecosystem processes. Final contract report prepared for the Northern Spotted Owl EIS Team, USDA Forest Service. Portland, OR: The Xerces Society. 51 pp. + map. (From Table 1)

From Table 1, Olson 1992:

"This list is not exhaustive; invertebrate distributions and diversity are not well known in the Pacific Northwest and not all available published species accounts were reviewed, nor all appropriate specialists interviewed. Only four taxonomic revisions were examined for this list, and only six of the roughly fifty or so specialists familiar with the regional fauna were interviewed. This list is intended to provide examples to clarify taxonomic and ecological trends, and should be viewed as a tool for direction, not as a catalog of all relevant species. Some species reviewed possessing relatively limited distributions across several counties were arbitrarily excluded to focus on species with extremely narrow known ranges. All of the species

Appendix 5-G

Viability Ratings of Fish Stocks at Risk, Under the Five Final Environmental Impact Statement Alternatives

Appendix 5-G
Viability Ratings of Fish Stocks at Risk, Under the Five Final Environmental Impact Statement Alternatives

A five-class rating scheme for viability was used.

Province	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
Olympic	L 1,4,5	M 3,4,5	MH 3,4,5	MH 3,4,5	L 1,4,5
WA Cascades	L 1,4,5	ML 2,4,5	ML 2,4,5	M 3,4,5	L 1,4,5
OR Coast Range	L 1,4,5	L 1,4,5	ML 2,4,5	M 3,4,5	L 1,4,5
OR Cascades	L 1,4,5	L 1,4,5	L 1,4,5	M 3,4,5	L 1,4,5
Klamath	L 1,4,5	L 1,4,5	L 1,4,5	M 3,4,5	L 1,4,5

1 - Approximately <25% area of key watersheds within alternative
2 - Approximately 26-50% area of key watersheds within alternative
3 - Approximately >50% area of key watersheds within alternative
4 - Has no watershed restoration program
5 - Lacks adequate riparian management area standards

Viability ratings codes:

H = high
MH = medium high
M = medium
ML = medium low
L = low

Appendix 5-H

Species with Risk to Viability, All Taxonomic Classes, Closely Associated With Old-Growth Forests in National Forests Within the Range of the Northern Spotted Owl

Table of Contents

Appendix 5-H
Species With Risk to Viability - Non-vascular Plants

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Non-vascular Plants										
1. Live wood										
Lichens										
Alectoria sarmentosa	1				1					1
Bryoria capillaris	1				1					1
Bryoria tortuosa	1				1					1
Calicium abietinum					1					
Calicium adaequatum					1					
Calicium adspersum					1					
Calicium glaucellum					1					
Calicium viride					1					
Chaenotheca chrysocephala					1					
Chaenotheca ferruginea					1					
Chaenotheca subroscida					1					
Hypnum circinale					1					
Lobaria hallii	1				1					1
Lobaria linita	1				1					1
Lobaria oregana	1				1					1
Lobaria pulmonaria	1				1					1
Microcalicium arenarium					1					
Nephroma antiquorum	1				1					1
Nephroma isidiosum	1				1					1
Nephroma occultum	1				1					1
Pseudocyphellaria anomala	1				1					1
Pseudocyphellaria anthraspis	1				1					1
Pseudocyphellaria aurata	1				1					1
Pseudocyphellaria crocata	1				1					1
Pseudocyphellaria rainierensis	1				1					1
Sphaerophorus globosus	1				1					
Sticta weigelii	1				1					1
Usnea longissima	1	1	1	1	1	1				1
Teloschistes flavicans	1	1	1	1	1	1				1

Appendix 5-H
Species With Risk to Viability - Non-vascular Plants (continued)

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Liverworts										
Herbertus aduncus	1				1	1				1
Herbertus sakuraii	1	1	1	1	1	1				1
Ptilidium californicum (CA only)	1	1	1	1	1					1
Ptilidium californicum (OR & WA)					1					
Radula bolanderi					1					
Scapania bolanderi					1					
Mosses										
Antitrichia curtipendula	1				1					
Iwatsukiella leucotricha	1	1	1	1	1	1				1
Pterigynandrum filiforme	1				1	1				1
Ulota megalospora (CA only)	1	1	1	1	1	1				1

Appendix 5-H
Species With Risk to Viability - Non-vascular Plants (continued)

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
2. Decaying wood										
Lichens										
Icmadophila ericetorum	1				1					1
Liverworts										
Bazzania ambigua	1				1					
Bazzania denudata	1				1					
Bazzania tricrenata	1				1					
Blepharostoma trichophyllum	1				1					
Calypogeia azurea	1				1					
Calypogeia fissa	1				1					
Calypogeia muelleriana	1				1					
Calypogeia suecica	1				1					
Cephalozia bicuspidata ssp. lammersiana	1				1					
Cephalozia connivens	1				1					
Cephalozia lunulifolia	1				1					
Diplophyllum albicans	1				1					
Diplophyllum plicatum	1				1					
Geocalyx graveolens	1				1					
Kurzia makinoana	1				1					
Lepidozia reptans	1				1					
Lophocolea bidentata	1				1					
Lophocolea cuspidata	1				1					
Lophocolea heterophylla	1				1					
Lophozia incisa	1				1					
Lophozia longiflora	1				1					
Riccardia latifrons	1				1					
Riccardia palmata	1				1					
Scapania umbrosa	1				1					
Mosses										
Brotherella roellii (WA Cascades only)	1	1	1	1	1	1	1	1	1	1
Buxbaumia piperi	1	1	1	1	1	1				1
Buxbaumia viridis	1	1	1	1	1	1				1
Herzogiella seligeri	1				1					
Orthodontium gracile (Redwoods no. CA)	1				1					

Appendix 5-H
Species With Risk to Viability - Non-vascular Plants (continued)

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Plagiothecium undulatum	1				1					
Pseudotaxiphyllum elegans	1				1					
Rhizomnium glabrescens	1				1					
Tetraphis geniculata	1	1	1	1	1	1				1
Tetraphis pellucida	1				1					

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E

3. Soil and bases of trees

Liverworts

Scapania americana	1				1					

Mosses

Anthoceros bulbiculosus	1				1					
Bartramiopsis lescurii	1	1	1	1	1	1	1	1	1	1
Brachythecium hylotapetum	1				1					1
Ditrichum schimperi	1				1					
Epipterygium tozeri	1				1					
Fissidens pauperculus	1				1					
Isopterygiopsis pulchella	1				1	1				1
Plagiomnium insigne	1				1					
Pohlia pacifica	1				1					
Rhizomnium nudum	1	1	1	1	1	1				1
Rhytidiopsis robusta	1				1					
Roellia roellii	1				1					
Schistostega pennata	1	1	1	1	1	1				1
Trichodon cylindricus	1				1					

Appendix 5-H
Species With Risk to Viability - Non-vascular Plants (continued)

4. Rock

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Liverworts										
Apometzgeria pubescens	1	1	1	1	1	1				1
Metzgeria conjugata	1	1	1	1	1	1				1
Radula brunnea	1	1	1	1	1	1				1
Mosses										
Andreaea heinemanii	1				1					1
Andreaea schofioldiana	1				1					1
Byrum gemmascens	1				1	1				1
Heterocladium macounii	1				1	1				1
Heterocladium procurrens	1				1	1				1
Plagiothecium piliferum	1				1	1				1

5. Water

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Liverworts										
Conocephalum conicum	1				1					
Pellia neesiana	1				1					
Tritomaria exsecta	1				1					
Tritomaria exsectiformis	1				1					
Tritomaria quinquedentata	1	1	1	1	1	1				1
Mosses										
Dichodontium pellucidum	1				1					
Dicranella palustra	1	1			1	1				1
Hookeria lucens	1				1					
Hygrohypnum bestii	1	1			1	1				1
Pleuroziopsis ruthenica	1	1	1	1	1	1	1	1	1	1
Porotrichum bigelovii	1				1					
Rhytidiadelphus subpinnatus	1				1					

Appendix 5-H
Species With Risk to Viability - Non-vascular Plants (continued)

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
6. Other										
Fungi										
Albatrellus caeryliopus	1	1	1		1					1
Aleuria rhenana	1	1	1	1	1	1	1	1	1	
Catathelasma ventricosa	1	1	1		1					1
Collybia bakerensis	1				1	1				1
Collybia racemosa	1	1			1	1				1
Cortinarius boulderensis	1	1	1		1					1
Cortinarius cyanites	1	1	1		1					1
Cortinarius olympianus	1	1	1		1					1
Cortinarius rainerensis	1	1	1		1					1
Cortinarius tabluaris	1	1	1		1					1
Cortinarius variipes	1	1	1		1					1
Cortinarius valgus	1	1	1		1					1
Ganoderma tsugae	1				1	1				1
Ganoderma oregana	1				1	1				1
Geopora cooperi	1				1	1				1
Gomphus kauffmanii	1	1	1		1					1
Gymnopilus punctifolius	1				1	1				1
Hericium abietis	1				1	1				1
Laetiporus sulfureus	1				1	1				1
Mycena lilacifolia	1				1	1				1
Mycena marginella	1				1	1				1
Mythicomyces corneipes	1	1			1	1				1
Otidea leporina	1	1			1	1				1
Otidea onotica	1	1			1	1				1
Otidea smithii	1	1			1	1				1
Oxyporus nobilissimus	1				1	1				1
Phaeocollybia kauffmanii	1		1		1					1
Pholiota scamba	1				1	1				1
Pholiota pulchella	1				1	1				1
Pleurocybella porrigens	1				1	1				1
Polyozellus multiplex	1	1	1		1					1
Rhodocybe speciosa	1				1	1				1
Sarcosphaera eximia	1				1					1
Sarcosoma mexicana	1	1			1	1				1

Appendix 5-H
Species With Risk to Viability - Non-vascular Plants (continued)

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Sparasis radicata	1				1	1				1
Tricholomopsis fulvescens	1				1	1				1
Mosses										
Ulota obtusiuscula					1					
TOTAL non-vasc.	133	38	31	19	147	49	4	4	4	82

Appendix 5-H
Species With Risk to Viability - Vascular Plants

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Vascular plants										
Allotropa virgata	1				1					
Chamaecyparis lawsoniana (so.)	1				1					1
Coptis asplenifolia					1					
Cypripedium fasciculatum			1	1						
Cypripedium montanum			1	1						
Pyrola uniflora	1				1					
Taxus brevifolia (nw Cal.)	1				1					
TOTAL vascular	4	0	2	2	5	0	0	0	0	1

Appendix 5-H
Species With Risk to Viability - Invertebrates

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E

Invertebrates

Phylum Arthropoda

Class Diplopoda (millipedes)

Order Chordeumatida

Family Caseyidae

Caseya benodictae
Caseya briophila
Caseya bucketti
Caseya longiloba
Caseya megasoma
Caseya megasoma
Caseya shastaensis
Harpaphe haydeniana
Metopiona sheari
Ochrogramma heterogona
Ochrogramma formulosa
Ochrogramma haigi
Opiona bifurcata
Opiona casualis
Opiona communis angusta
Opiona confusa
Opiona distincta
Opiona exigua
Opiona facetia
Opiona fisheri
Opiona goedeni
Opiona scytonotoides
Opiona siliquae
Tuhaphe levii

(Not rated by alternative)

Appendix 5-H
Species With Risk to Viability - Invertebrates (continued)

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E

Class Arachnida

Order Araneida (spiders)

Family Agelenidae

Cybaeina minuta

Order Phalangida (harvestman)

Cryptomaster leviathan
Isolachus spinosus
Pentanychus hamatus
Pentanchyus clavatus
Pentanchyus bilobatus
Pentanchyus flavescens
Pentanchyus pacificus

Class Insecta (insects)

Order Orthoptera

Boonacris alticola
Pristoceuthophilus celatus
Pristoceuthophilus cercalis
Pristoceuthophilus sargentae
Tropidischia xanthostoma

(Not rated by alternative)

Order Hemiptera

Boreostolis americanus
Plinthisus longisetosus
Thylochromus nitidulus
Eurychilopterella sp.
Phytocoris nobilis
Pithanus maerkelii
Polymerus castellaeni
Vanduzeenia borealis
Acalypta lillianis
Acalypta saundersi
Derephysia foliacea

Order Coleoptera

Pterecus humboldti
Cychrus tuberculatus
Metrius contractus

Appendix 5-H
Species With Risk to Viability - Invertebrates (continued)

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Promecognathus laevissimus										
Zacotus mathewsii										
Omus dejeani										
Lobosoma horridum										
Acneus beeri										
Acneus burnelli										
Cicindela columbica										
Pterostichus rothi										
Order Plecoptera										
Nemoura wahkeena										
Solperia fenderi										
Order Trichoptera										
Eobrachycentrus gelidae										
Agapetus denningi										
Homoplecta schuhi										
Ochrotrichia alsea										
Lepidostoma goedeni										
Apatania tavaia										
Farula davisi										
Farula jewetti										
Farula reaperi										
Limnephilus alconura										
Limnephilus atereus										
Neothremma andersoni										
Oligophlebodes mostbento										
Philocasca oron										
Dolophilodes oregona										
Tinodes siskyou										
Rhyacophila ambilis										
Rhyacophila colonus										
Rhyacophila fenderi										
Rhyacophila haddocki										
Rhyacophila lineata										
Rhyacophila mosana										
Rhyacophila unipunctata										
Desmona bethula										
Cryptochia shasta										

(Not rated by alternative)

Appendix 5-H
Species With Risk to Viability - Invertebrates (continued)

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Goeracea oregona										
Neothremma genella										
Neothremma siskyou										
Ochrotrichia vertreesi										
Abellan hydropsyche										

Phylum Mollusca

Fluminicola columbiana										
Fisherola nuttalli nuttalli										
Monadenia fidelis minor										
Monadenia troglodytes chaceana										
Monadenia troglodytes troglodytes										
Monadenia troglodytes wintu										
Monadenia fidelis pronotis										
Monadenia setosa										
Vespericola karokorum										
Juga hemphilli hemphilli										
Juga hemphilli dallesensis										
Juga hemphilli subsp.										
Juga (J.) n. sp. 1										
Juga (J.) n. sp. 3										
Juga (O.) n. sp. 1										
Juga (O.) n. sp. 2										
Juga (C.) actitilosa										
Juga (C.) occata										
Amnicola (L.) n. sp.										
Vorticifex neritoides										
Physella columbiana										
Fluminicola seminalis										
Lanx alta										
Lanx patelloides										
Helisoma newberryi newberryi										
Vespericola columbiana columbiana										
Hemphillia malonei										
Hemphillia pantherina										

(Not rated by alternative)

Appendix 5-H
Species With Risk to Viability - Invertebrates (continued)

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Hemphillia glandulosa glandulosa										
Hemphillia barringtoni										
Prophysaon coeruleum										
Prophysaon dubium										
Monodenia fidelis columbiana										
Monadenia fidelis beryllica										
Monadenia fiddelis celeuthia										
Monadenia fidelis ochromphalous										
Monadenia fidelis leonina										
Monadenia fidelis klamathica										
Monadenia churchi										
Trilobopsis roperi										
Trilobasis tehamana										
Vespericola shasta										
Vespericola sierrana										
Vespericola megasoma euthales										
Megomphix hemphilli										
Anodonta wahlamatensis										
Juga (Oreobasis) chacei										
Juga (Oreobasis) orickensis										
Lanx subrotundata										
Monadenia callipeplus										
Monadenia cristulata										
Monadenia fidelis salmonensis										
Monadenia fidelis scottiana										
Monadenia rotifera										
Haplotrema voyanum										
Helminthoglypta hertleini										
Deroceras hesperium										
Anodonta californiensis										

(Not rated by alternative)

Appendix 5-H
Species With Risk to Viability - Fish

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E

Fish

No. of fish stocks at risk:	112	112	112	112	112	112	112	112	112	112

See Appendix 5-K for the full list of fish stocks.

Appendix 5-H
Species With Risk to Viability - Amphibians and Reptiles

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Amphibians										
Oregon Slender salamander	1				1					1
Larch Mt. salamander	1	1	1	1	1	1				1
Siskiyou Mt. salamander	1	1	1	1	1	1	1	1	1	1
Del Norte salamander	1	1	1		1	1				1
Van Dyke's salamander (Coastal, Olym. Pe	1	1	1	1	1	1	1	1	1	1
Van Dyke's salamander (Cascades)	1	1	1	1	1	1	1	1	1	1
Dunn's salamander	1				1					
Black salamander	1				1					1
Clouded salamander (Oregon)	1				1					1
Clouded salamander (California)	1	1			1					1
Pacific giant salamander	1				1					1
Cope's giant salamander	1				1					1
Olympic salamander (R.olympicus)	1	1	1		1	1				1
Olympic salamander (R.kezeri)	1	1	1	1	1	1	1	1	1	1
Olympic salamander (R. cascadae)	1	1	1	1	1	1	1	1		1
Olympic salamander (R. varigatus)	1	1	1	1	1	1	1	1	1	1
Northwestern salamander	1				1					1
Shasta salamander	1	1	1	1	1	1	1	1	1	1
Roughskin newt	1				1					
Tailed frog	1	1	1		1	1				1
TOTAL	20	12	11	8	20	11	7	7	6	18
Reptiles										
(no species)	0	0	0	0	0	0	0	0	0	0

Appendix 5-H
Species With Risk to Viability - Birds

Birds

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Marbled murrelet	1	1	1	1	1	1	1	1	1	1
Barrow's goldeneye	1				1					
Bufflehead	1	1	1	1	1					
Harlequin duck	1	1	1		1					
Northern goshawk	1	1			1	1				1
Northern pygmy-owl	1				1					
Flammulated owl	1	1	1	1	1					1
Northern spotted owl	1				1	1				1
Great gray owl	1	1	1	1	1					
Vaux's swift	1				1					
Pileated woodpecker	1				1					
White-headed woodpecker	1	1	1	1	1					1
Black-backed woodpecker	1	1			1					1
Three-toed woodpecker	1									
Red-breasted sapsucker	1				1					
Williamson's sapsucker	1				1					
Hammond's flycatcher	1				1					1
Pygmy nuthatch	1	1	1	1	1					
Red crossbill					1					
TOTAL birds	**18**	**9**	**7**	**6**	**18**	**3**	**1**	**1**	**1**	**7**

Appendix 5-H
Species With Risk to Viability - Mammals

Mammals

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Marten (Olympic Peninsula)	1	1	1	1	1	1	1			1
Marten (Washington Cascades)	1				1					
Marten (Oregon Coast range)	1	1	1	1	1	1	1			1
Marten (Oregon Cascades)	1	1	1		1					1
Marten (Klamath Province)	1				1					
Fisher (CA, so. OR)	1	1	1		1	1				1
Fisher (no. OR, WA)	1	1	1	1	1	1	1	1	1	1
Red tree vole (P.longicaudus)	1	1	1	1	1	1	1	1		1
Red tree vole (P.pomo)	1	1	1	1	1	1	1	1		1
Big brown bat	1				1					
Silver- haired bat	1				1					1
Lynx	1	1	1	1	1	1				1
TOTAL mammals	12	8	8	6	12	7	5	3	1	9

1 = denotes viability risk
blank = denotes no viability risk

Appendix 5-I

Comparison of Species Lists of Terrestrial (Non-Fish) Vertebrates: Final Environmental Impact Statement and Scientific Analysis Team

Appendix 5-I
Comparison of Species Lists - Amphibians and Reptiles

List of species with viability risk under 1 or more alternatives from SAT evaluation.

	On FEIS list of 32 spp.?	On SAT long list?	On SAT short list?	Alt. B Mod. Risk	Alt. B High Risk
Amphibians					
Oregon Slender salamander		X	X		
Larch Mt. salamander		X	X	X	
Siskiyou Mt. salamander		X	X	X	X
Del Norte salamander	X	X	X	X	
Van Dyke's salamander (Coast., Oly. Pen.)		X	X	X	X
Van Dyke's salamander (Cascades)		X	X	X	X
Dunn's salamander		X	X		
Black salamander	X	X	X		
Clouded salamander (Oregon)		X	X		
Clouded salamander (California)		X	X	X	
Pacific giant salamander		X	X		
Cope's giant salamander		X	X		
Olympic salamander (R.olympicus)	X	X	X	X	
Olympic salamander (R.kezeri)	X	X	X	X	X
Olympic salamander (R. cascadae)	X	X	X	X	X
Olympic salamander (R. varigatus)	X	X	X	X	X
Northwestern salamander	X	X	X		
Shasta salamander		X	X	X	X
Roughskin newt	X	X	X		
Tailed frog	X	X	X	X	
Reptiles					
(no species)					

SAT = Scientific Analysis Team
FEIS = Final Environmental Impact Statement

Appendix 5-I
Comparison of Species Lists - Birds

List of species with viability risk under 1 or more alternatives from SAT evaluation.

	On FEIS list of 32 spp.?	On SAT long list?	On SAT short list?	Alt. B Med. Risk	Alt. B High Risk
Birds					
Marbled murrelet	X	X	X	X	X
Barrow's goldeneye		X	X		
Bufflehead		X	X	X	
Harlequin duck		X	X	X	
Northern goshawk	X	X	X	X	
Bald eagle	X	X	X		
Northern pygmy-owl		X	X		
Flammulated owl		X	X	X	
Great gray owl		X	X	X	
Vaux's swift	X	X	X		
Pileated woodpecker		X	X		
Hairy woodpecker	X	X	X		
White-headed woodpecker		X	X	X	
Black-backed woodpecker		X	X	X	
Three-toed woodpecker		X	X		
Red-breasted sapsucker	X	X	X		
Williamson's sapsucker		X	X		
Hammond's flycatcher		X	X		
Western flycatcher	X	X	X		
Winter wren	X	X	X		
Pygmy nuthatch		X	X	X	
Chestnut-backed chickadee	X	X	X		
Golden-crowned kinglet	X	X	X		
Brown creeper	X	X	X		
Hermit warbler	X	X	X		
Varied thrush	X	X	X		
Red crossbill		X	X		

SAT = Scientific Analysis Team
FEIS = Final Environmental Impact Statement

Appendix 5-I
Comparison of Species Lists - Mammals

List of species with viability risk under 1 or more alternatives from SAT evaluation.

	On FEIS list of 32 spp.?	On SAT long list?	On SAT short list?	Alt. B Mod. Risk	Alt. B High Risk
Mammals					
Marten (Olympic Peninsula)		X	X	X	X
Marten (Washington Cascades)		X	X		
Marten (Oregon Coast range)		X	X	X	X
Marten (Oregon Cascades)		X	X	X	
Marten (Klamath Province)		X	X		
Fisher (CA. so. OR)	X	X	X	X	
Fisher (no. OR, WA)	X	X	X	X	X
Pacific shrew	X	X	X		
Douglas squirrel	X	X	X		
Western red-backed vole	X	X	X		
Shrew-mole	X	X	X		
Red tree vole (P.longicaudus)	X	X	X	X	X
Red tree vole (P.pomo)	X	X	X	X	X
Big brown bat	X	X	X		
Silver- haired bat	X	X	X		
Fringed myotis	X	X	X		
Little brown bat	X	X	X		
Yuma myotis	X	X	X		
California myotis	X	X	X		
Keen's myotis	X	X	X		
Lynx		X	X	X	

SAT = Scientific Analysis Team
FEIS = Final Environmental Impact Statement

Appendix 5-J

Species for Which Information is Most Limited

Appendix 5-J
Species for Which Information is Most Limited

Species	May be at least locally common to abundant	Rare to uncommon but widespread	Locally endemic where known	Closely assoc'd w/ old-growth forests and conditions	Specialized to specific substrates or edaphic conditions	High elevation forests	On fringe of range of northern spotted owl	Other, may still need further study
NON-VASCULAR PLANTS								
1. Live wood								
Lichens								
Bacidia herrei								X
Cavernularia hultenii								X
Cavernularia lophyrea								X
Cetraria californica	X			X				
Cetrelia cetrarioides	X			X				
Collema nigrescens		X						
Dendriscocaulon intricatulum								X
Heterodermia leucomelos								X
Hypocenomyce friesii								X
Hypogymnia duplicata								X
Hypogymnia oceanica								X
Hypogymnia rugosa								X
Leptogium cyanescens		X						
Lichinodium canadense								X
Lopadium pezizoideum								X
Pannaria leucostictoides								X
Pannaria rubiginosa								X
Pannaria saubinetii								X
Parmotrema chinense		X		X				
Parmotrema crinitum		X		X				
Platismatia norvegica		X		X				
Ramalina thrausta								X

Appendix 5-J

Species for Which Information is Most Limited (continued)

Species	May be at least locally common to abundant	Rare to uncommon but widespread	Locally endemic where known	Closely assoc'd w/ old growth forests and conditions	Specialized to specific substrates or edaphic conditions	High elevation forests	On fringe of range of northern spotted owl	Other; may still need further study
Liverworts								
Doulinia ovata	X				X			
Mosses								
Pseudoleskea stenophylla	X				X			
2. Decaying wood								
Mosses								
Pseudoleskea saviana								X
3. Soil and bases of trees								
Lichens								
Peltigera neopolydactyla								X
Peltigera pacifica								X
4. Rock								
Mosses								
Lescuraea incurvata								X
Pseudoleskea incurvata	X				X			
Pseudoleskea patens	X				X			
Pseudoleskea radicosa	X				X			
Thamnobryum neckeroides	X							

5. Water

(no species)

Appendix 5-J
Species for Which Information is Most Limited (continued)

Species	May be at least locally common to abundant	Rare to uncommon but widespread	Locally endemic where known	Closely assoc'd w/ old-growth forests and conditions	Specialized to specific substrates or edaphic conditions	High elevation forests	On fringe of range of northern spotted owl	Other, may still need further study
6. Other								
Fungi								
Collybia racemosa			X	X	X			
Elaphomyces granulatus	X							
Elaphomyces muricatus	X							
Hysterangium crassirhachis	X							
Hysterangium setchellii	X							
Rhizopogon atroviolaceus	X							
Tuber rufum	X							
TOTAL NONVASCULAR PLANTS	14	5	1	6	6	0	0	19
VASCULAR PLANTS								
Orchids								
Listera borealis								X
Platanthera sparsiflora			X		X			
Grape ferns								
Botrychium pumicola								X
Others with Listing Status								
Asarum wagneri								X
Fritillaria gentneri								X
Silene nuda								X

Appendix 5-J
Species for Which Information is Most Limited (continued)

Species	May be at least locally common to abundant	Rare to uncommon but widespread	Locally endemic where known	Closely associ'd w/ old-growth forests and conditions	Specialized to specific substrates or edaphic conditions	High elevation forests	On fringe of range of northern spotted owl	Other, may still need further study
Viola renifolia		X						X
Others Without Listing Status								
Angelica tomentosa								X
Berberis pumila					X			
Synthyris schizantha								X
TOTAL VASCULAR PLANTS	0	1	1	0	2	0	0	8
INVERTEBRATES (all poorly known and require study)	0	0	0	0	0	0	0	149
FISH	0	0	0	0	0	0	0	0
TERRESTRIAL VERTEBRATES								
Amphibians								
TOTAL AMPHIBIANS	0	0	0	0	0	0	0	0

Appendix 5-J
Species for Which Information is Most Limited (continued)

Species	May be at least locally common to abundant	Rare to uncommon but widespread	Locally endemic where known	Closely assoc'd w/ old-growth forests and conditions	Specialized to specific substrates or edaphic conditions	High elevation forests	On fringe of range of northern spotted owl	Other; may still need further study
Reptiles								
0 reptile forms on short list	0	0	0	0	0	0	0	0
Birds								
TOTAL BIRDS	0	0	0	0	0	0	0	0
Mammals								
Hoary bat		X		X				X
Long-legged myotis				X				X
Yuma myotis				X				X
California myotis				X				X
Keen's myotis		X		X				X
Long-eared myotis				X				X
Fringed myotis				X				X
Little brown myotis				X				X
Pallid bat								X
Wolverine						X		
TOTAL MAMMALS	0	2	0	8	0	1	0	9

Appendix 5-K

Strategy for Managing Habitat of At-Risk Fish Species and Stocks in National Forests Within the Range of the Northern Spotted Owl

Table of Contents

Appendix 5-K
Strategy for Managing Habitat of At-Risk Fish Species

List of Tables

List of Figures

APPENDIX 5-K

Strategy for Managing Habitat of At-Risk Fish Species and Stocks in National Forests Within the Range of the Northern Spotted Owl

INTRODUCTION

Many fish stocks of anadromous salmonids (*Oncorhynchus spp.)* are presently in questionable conditions. (A stock is a locally adapted population that is reproductively isolated from other stocks [Ricker 1972]). The Endangered Species Committee of the American Fisheries Society recently identified 214 fish stocks in California, Oregon, Washington, and Idaho that are in need of special management considerations because of low or declining numbers (Nehlsen et al. 1991). Another, the Illinois River winter steelhead trout (*O. mykiss*), is being considered for threatened and endangered status. Another 101 were believed to face a high risk of extinction and 58 a moderate risk. An additional 106 fish stocks are believed to already be extinct (Nehlsen et al. 1991). To date, 4 have been listed as threatened and endangered. Figure 5-K-1 shows the distribution and status of these fish stocks in the area of the northern spotted owl. One, the Sacramento River winter chinook salmon (*Oncorhynchus tshawytscha*), has been listed under the Endangered Species Act. Higgins et al. (1992) and USDI (1992) also identified stocks anadromous salmonids that were in danger of extinction. These fish stocks are primarily subsets of those identified by Nehlsen et al. (1991). For this report, we only considered fish stocks identified by Nehlsen et al. (1991).

Primary factors contributing to the decline of anadromous salmonid stocks include: (1) degradation and loss of freshwater and estuarine habitats due to urbanization, agriculture, livestock grazing, mining, timber harvest, and dams; (2) over-exploitation in commercial and recreational fisheries; (3) migratory impediments such as dams; and (4) loss of genetic integrity due to the effects of hatchery practices and introduction of non-local stocks (Nehlsen et al. 1991). Often two or more of these factors operating in concert are responsible for a decline in fish stock numbers.

The status of anadromous fish stocks in northern California, Oregon, and Washington reflects the condition of fish throughout North America. Williams et al. (1989) listed 364 species and subspecies of fish in North America that are in need of special management considerations because of low population numbers. This is an increase of 139 species since 1979. No species were removed from the list as a result of successful recovery programs. Allendorf (1988) reported that a large proportion of the freshwater fish fauna in western North America is in precarious condition and in need of special attention. He noted that the potential rates of loss of biodiversity rival those observed in the tropics. Moyle and Williams (1990) found that percent of the native freshwater fish of California were extinct or in need of immediate action. The condition of these fish is attributable to the same suite of factors that are responsible for the state of anadromous salmonid stocks (Williams et al. 1989, Moyle and Williams 1990).

Loss and degradation of freshwater habitats are the most frequent factors responsible for the decline of anadromous salmonids stocks (Nehlsen et al. 1991). This includes decreases in the quantity and quality of habitat and the fragmentation of habitat into isolated patches. These changes have resulted from an array of human activities including urbanization, agricultural activities, timber harvest and associated activities, livestock grazing, water withdrawal and diversion, and dams (Nehlsen et al. 1991). In the region of the northern spotted owl the first three are the activities that are primarily responsible for the loss or decrease in the quality of fish habitat. On lands within the range of the northern spotted owl managed by the Forest Service, the primary land management activities affecting fish habitat are timber harvest and associated activities, and some grazing

Freshwater habitat may be disproportionately more important for the survival and persistence of anadromous salmonid stocks found in the range of the northern spotted owl than it would be for species and fish stocks found in more northerly areas. All anadromous salmonids spend a portion of their life cycle in freshwater. Adults return from the ocean to reproduce. Early life history stages (i.e., eggs, alevins, fry and juveniles) also occur in freshwater. Duration of freshwater residence ranges from a few days or weeks to 2 or more years depending on species and fish stocks.

Ocean conditions for anadromous salmonids in the range of the northern spotted owl are highly variable. The oceanic boundary between cool, nutrient rich northern currents and warm, nutrient poor southern currents often occur off the coast of northern California, Oregon and Washington (Bottom et al. 1986). Favorable conditions exist when the boundary is more southerly, which has occurred on average of 1 in 4 years in the last 40 years (Bottom et al. 1986). During favorable ocean conditions, survival of at least some fish stocks is greater than during less favorable conditions (Nickelson 1986).

Additionally, the coast in this region has a low shoreline/coastline ratio (Bottom et al. 1986). The consequence of this is that there are few well developed estuaries and other nearshore rearing areas. These areas are sites of early growth in the ocean, which is important for survival in the marine environment (Hager and Noble 1976, Bilton et al. 1982, Ward et al. 1989, Henderson and Cass 1991, Pearcy 1992). This is particularly important during times of unfavorable ocean conditions. In much of the region of the northern spotted owl, fish moving to the ocean do not have nearshore areas in which to grow. In contrast, British Columbia and southeast Alaska have higher shoreline/coastline ratios and thus more and better nearshore habitats. Because of the scarcity of nearshore habitats and the variable ocean conditions, the existence of adequate quantities and qualities of freshwater habitat is more critical for the survival and persistence of fish stocks in the range of the northern spotted owl than it is for fish stocks in more northerly areas. Compared to fish in areas with more stable ocean conditions and better developed nearshore habitats, fish in the region of the northern spotted owl are more dependent on freshwater environments to achieve larger sizes, which increase probability of marine survival

CHARACTERISTICS OF FISH HABITAT IN NATIONAL FORESTS WITHIN THE RANGE OF THE NORTHERN SPOTTED OWL

Characteristics of High Quality Fish Habitat Conditions

Assemblages of anadromous salmonids associated with forests within the range of the northern spotted owl include five species of Pacific salmon and two species of trout (Table 5-K-l). Each species has a variable number of discreet fish stocks that are genetically isolated from each other and specifically adapted to local habitat characteristics. It is quite common for several species and numerous fish stocks to coexist in the same sections of stream systems throughout their range. As a result, the anadromous salmonid assemblage of most stream systems is a complex mixture of several species and stocks. Each species and fish stock has exacting but different habitat requirements (see Bjornn and Reiser 1991), requiring diverse and complex habitats maintain populations of all groups.

The life history of anadromous salmonids adds to the complexity of freshwater habitat needs. All anadromous salmonids spawn in freshwater. Juvenile fish rear in streams and lakes for variable periods of time before moving to the ocean where they grow to adulthood (see Meehan and Bjornn 1991, Groot and Margolis 1991). Some species reside in freshwater for only a few weeks (e.g., pink and chum salmon), but more commonly, juveniles reside in freshwater for one to several years (e.g., coho salmon and cutthroat trout), growing to 8 inches or more in size before entering the ocean. Habitat needs are different for each species, age class and size class of juvenile fish, and for each season of the year (Bjornn and Reiser 1991, Groot and Margolis 1991). Therefore, freshwater habitats must provide good water quality and quantity, as well as numerous substrate and habitat types, cover, and food resources to accommodate the habitat needs of mixed anadromous salmonid assemblages.

Freshwater habitat requirements of anadromous salmonids have been well documented in the scientific literature (see Bjornn and Reiser 1991, Groot and Margolis 1991), A weakness of the documentation, however, is that habitat descriptions are species specific. The descriptions do not take into account that almost all habitats used by anadromous fish must accommodate complex assemblages of species and stocks, rather than a single species or stock. The more complex the salmonid community, the more complex are the habitats needed to meet the requirements of all species and sizes of fish at all seasons of the year.

The following characteristics of productive natural habitats for anadromous salmonids apply to 3rd- to 5th-order streams (Strahler 1957) which may support a mixed species assemblage of juvenile anadromous salmonids. (Streams of these orders are generally 15-50 feet wide and are typical of streams managed by the Forest Service within the range of the northern spotted owl.) Not all of the desired features are expected to occur in a specific reach of stream, but they generally will occur throughout a productive watershed. Factors such as climate and geology can exert strong influences on productivity of streams and influence fish habitat. Although these are beyond human control (Naiman et al. 1992), their effects must be considered in any management decisions.

Water Quality - All salmonids require high quality water for spawning, rearing, and migration (Bjornn and Reiser 1991). An abundance of cool (generally <68°F), well oxygenated water, free of excessive amounts of suspended sediments (Sullivan et al. 1987) and other pollutants required at all times of the year. Water temperatures must be within the range that synchronize the time of migration and emergence of fish and other aquatic organisms (Sweeney and Vannote 1978, Quinn and Tallman 1987).

Water Quantity - Adequate flow is critical at specific times in life cycles for spawning, rearing, and migration. The fish are adapted to natural variations in flow regimes, but are adversely affected by disturbances that alter natural flow cycles (Statzner et al. 1988).

Channel Characteristics - The most productive stream systems for mixed salmonid assemblages have gradients <5 percent. They are comprised of constrained (i.e., ratio of valley width/active channel width <3) and unconstrained (i.e., ratio of valley width/active channel width >3) reaches, which contain a broad diversity and complexity of habitat features. Constrained reaches generally have fewer juvenile fish and less diverse assemblages than unconstrained areas. Constrained reaches are important, however, as sources of cool water (McSwain 1987), holding areas for adult salmonids, and are avenues of transport for sediment, wood, and other materials to unconstrained reaches (Naiman et al. 1992).

Unconstrained reaches are generally sites of high fish densities. They are also sites of sediment, organic material, and nutrient storage and processing (Stanford and Ward 1988). High quality habitats maintain a balance between high quality pools, riffles, glides, and side channels. Cover features such as large woody debris, boulders, undercut banks, overhanging vegetation, deep water, and surface turbulence are abundant in high quality habitats. Substrates consist of a variety of particle sizes ranging from silts to boulders to accommodate the spawning and rearing needs of all species (Everest et al. 1987, Sullivan et al. 1987). Spawning gravels contain low percentages of fine sediments, generally <20 percent (see Bjornn and Reiser 1991). Channels are free of obstructions that may interfere with the upstream or downstream migration of adult or juvenile salmonids.

Riparian Vegetation - Riparian vegetation regulates the exchange of nutrients and material from upland forests to streams (Swanson et al. 1982, Gregory et al. 1991). Large conifers a mixture of large conifers and hardwoods are found in riparian zones along all streams in the watershed, including those not inhabited by fish (Naiman et al. 1992). Stream banks are vegetated with shrubs and other low growing woody vegetation. Root systems in stream banks of the active channel stabilize banks, allow development and maintenance of undercut banks, and protect banks during large storm flows (Sedell and Beschta 1991).

Watershed Conditions - There is a strong connection among all parts of the watershed (Naiman et al. 1992). Upland portions of watersheds are well vegetated, generally stable, and free from chronic and accelerated sedimentation. Watersheds are free from disturbances that alter natural streamflow regimens, the quality of water emanating from uplands, and delivery of large wood and sediment to streams occupied by fish (Naiman et al. 1992). Unstable headwall areas are vegetated with large conifers, or a combination of conifers and hardwoods.

The wide range of natural variation of individual factors and the complex interplay between stream habitat variables (e.g., numbers of pools and pieces of large wood, percent fine sediment, and water temperature) make it difficult to quantitatively establish levels for habitat features.

It is also difficult to quantify direct linkages among processes and functions outside the stream channel to in-channel conditions and biological variables.

Stream habitat variables should not be used as management goals in and of themselves. No target management or threshold level for these habitat variables can be uniformly applied to all streams. While this approach is appealing in its simplicity, it does not allow for natural variation among streams (Gregory et al. 1991; Rosgen 1988; and Ralph et al. unpub.). These habitat parameters must be viewed collectively as part of the larger issue of watershed health and maintenance of natural physical and biological integrity (Karr 1991; Naiman et al. 1992).

Current Conditions of Fish Habitat

Fish habitat in National Forests and other lands within the range of the northern spotted owl is currently in less than optimal condition (Hicks et al. 1991, Bisson et al. 1992). Habitat has been lost or the quality reduced because of past (Sedell and Luchessa 1982, Benner 1992, Bisson et al. 1992) and present land management and regulatory activities (Bisson and Sedell 1984, Grant 1986, Salo and Cundy 1987, Meehan 1991). These trends in habitat conditions represent the cumulative effects of these actions (Hicks et al. 1991).

The number of large, deep pools (i.e., >6 ft deep and >50 yd.2 surface areas) in many tributaries of the Columbia River have decreased in the past 50 years (Sedell and Everest 1991). This determined by comparing quantitative habitat surveys done recently with surveys done by the Bureau of Fisheries, now the National Marine Fisheries Service, between 1934 and 1941 (Rich 1948, Bryant 1949, Bryant and Parkhurst 1950, Parkhurst 1950a-c, Parkhurst et al. 1950). The Bureau of Fisheries surveys are unique because they are the only long-term data set that quantifies fish habitat in a way that is replicable over time. In the Washington and Oregon Cascade Mountains, the historical surveys were generally in late-successional Douglas-fir forests that had not been extensively roaded and harvested.

Overall, there has been a 58 percent reduction in the number of large, deep pools in resurveyed streams in National Forests within the range of the northern spotted owl in western and eastern Washington (Table 5-K-2). A similar trend was found in streams on private lands in coastal Oregon where large, deep pools decreased by 80 percent (Table 5-K-2). Primary reasons for loss of pools are filling by sediments (Megahan 1982), loss of pool forming structures such boulders and large wood (Bryant 1980, Sullivan et al. 1987), and loss of channel sinuosity channelization (Furniss et al. 1991, and Benner 1992).

The Wind River in the Gifford Pinchot National Forest in Washington was the exception to the trend. Large, deep pools increased between 1937 and 1992 (Tab]e 5-K-2). The upper western portion of the Wind River burned in the 1910's during the Yacolt Burn. Its channels were also cleared and used for log drives. Recovery has been a result of Forest Service restoration efforts and the flood of 1964, which probably helped to return large wood and boulders into the upper tributaries of the Wind River basin.

Ralph et al. (unpub.) reported the loss of pools in streams in basins with moderate levels timber harvest (i.e., <50 percent of the basin harvested in the last 40 years) to intensive levels of timber harvest (i.e., >50 percent of the basin harvested within the last 40 years and a road density of >5.3 miles per mile^2) in western Washington. Habitat features in stream segments draining basins with old-growth forests were compared to those in streams in basins with moderate and intensive timber harvest levels. In streams in basins with moderate harvest levels,

the percent of the area of pools and pool depth was less than that found in the streams draining old-growth forests. Pools >3 feet in depth were greatly reduced in the intensively harvested basins compared to those containing old growth. Bisson and Sedell (1984) reported similar results for other streams in western Washington. Such changes in habitat can result in a decrease in the diversity of the salmonid assemblage (Bisson and Sedell 1984; Reeves et al., in press).

The South Fork Umpqua River, in the Umpqua National Forest, was surveyed in 1937 by the Bureau of Commercial Fisheries on contract to the Forest Service. In 1990, seven tributaries were resurveyed by the Forest Service (J. Dose, Umpqua National Forest). In the area of two of these streams, Quartz and Castle Rock Creeks, there has been only a small amount of roading and logging and these streamserve as "controls" for evaluating changes in habitat conditions. The areas of the other five streams have been roaded and extensively logged, beginning in the early 1960's. Stream widths have increased 50 to 110 percent in the intensively logged areas. Width of one control stream decreased, while in the other it increased by 13 percent. Stream temperatures were taken on Quartz Creek and four of the five streams on various dates in July and August, 1937. All of the streams had temperatures below 65°F at that time. From 1980 to 1990, Quartz Creek, one of the controls, still exhibited a summer maximum water temperature regime below 65°F during the period July 1 to August 20. (Temperature data were not available from the other control, Castle Rock Creek.) Maximum water temperature in streams of four of the five logged areas when measured over the same 60-day summer period for the last 10 years, exceeded 65°F from 62 to 93 percent of the time. (Temperatures were not available from the fifth stream.) Numbers of pieces of large wood (>36°. diameter and 50' long) reflecthe same trends: much higher amount in the control streams than those in areas that have been roaded and harvested.

Causes and Implications of Habitat Degradation

Quantitative relationships between long-term trends in the abundance of fish and fish habitat and the effects of forest management practices have been difficult to establish (Hicks et al. 1991, Bisson et al. 1992). Because of inherent differences in stream size, storm magnitude, and geology, similar management practices may result in different responses (Hicks 1990). addition, extended time periods may be required before the effects of land management activities are expressed in streams.

Despite the lack of strong quantitative relationships between forest management activities (and other activities as well), a primary consequence of these activities has been the simplification of fish habitat (Hicks et al. 1991, Bisson et ai. 1992). Simplification of stream channels involves a decrease in the range and variability of stream flow velocities and depths (Kaufmann 1987), reductions in the amount of large wood and other structural elements (Bisson et al. 1987, Bilby and Ward 1991), elimination of physical and biological interactions between a stream and its floodplain (Naiman et al. 1992), and a decrease in the frequency and diversity of habitat types and substrates (Sullivan et al. 1987). Saio and Cundy (1987) and Meehan (1991) contain additional references detailing the link between effects of land management activities and the condition of fish habitat. The consequence of these changes has been a reduction in the diversity and quality of habitats available to fish.

A conference of management agencies and interested individuals and groups was convened recently by the Governor of Oregon (Oregon Governor's Coastal Salmonid Restoration Initiative, Newport, Oregon, 15-17 December 1992). For this conference, a panel of biologists from state and Federal agencies, universities, and private industries was asked to assess the degree to which various factors limit production of the wild species and stocks of anadromous salmonids in

coastal Oregon (coho, chinook, and chum salmon; steelhead and sea-run cutthroat trout). The evaluation of factors limiting production of the wild species and stocks of anadromous salmonids in coastal Oregon which were presented at the Governor's conference is the most extensive and detailed current evaluation in the coastal forests with spotted owls. Although it was a subjective assessment s it drew upon the expertise and judgement of numerous resource specialists, scientists, and fisheries managers. The intent was to provide the basis needed to develop programs to protect and restore the production of these fish.

Results of the assessment of limiting natural production for freshwater components, spawning and rearing habitat, are shown in Table 5-K-3. Spawning gravel quantity and quality were rated as having a high potential for limiting production of chum salmon and fall and spring chinook (Table 5-K-3). Gravel quality was believed to be poor because it was unstable (i.e., gravel containing developing eggs and alevins was subjected to movement during higher flows resulting in dislodgement or burial of eggs and alevins). Coho salmon production had a medium potential to be limited by gravel quantity and quality (Table 5-K-3). For coho salmon, gravel quantity was the responsible factor for the ranking. Lack of gravel in many streams probably is a consequence of both historic activities, such as splash damming. (Splash dams were structures constructed on streams that created ponds. Logs were either dropped into the pool behind the dam or in the channel downstream. The dam was opened, generally during periods of high stream flows. The resulting flow then transported the logs downstream. The consequence of this was that stream channels were straightened and often scoured to bedrock.) More recent activities, such as stream channel clearance, have also reduced or eliminated the amount of large wood that trapped and stabilized gravels in coastal streams.

Many facets of rearing habitat were identified as having high potentials to limit every species and race of anadromous salmonids except fall chinook salmon (Table 5-K-3). Increased water temperature was important along the south coast. Reduced numbers of deep complex pools and large sized wood in streams have resulted in a simplified rearing habitat that has a high potential for limiting several species and life history stages. Wetland and estuarine rearing areas have also been degraded. Riparian areas presently have very few large trees growing within 100 to 200 feet of the stream, suggesting that streamside recruitment of large wood will be deficient for decades. Alteration of both high and low streamflows caused by irrigation withdrawal, forest management activities, and stream channel simplification has limited the natural productivity of many streams. Species and fish stocks that rear in fresh water for extended periods were believed to be most affected.

Large Wood - Large wood is essential for creating and maintaining good fish habitat in streams (Bisson et al. 1987). Large wood influences the routing and storage of sediment and wood, affects the formation and distribution of habitat units, provides cover and complexity, and acts as a substrate for biological activity (Swanson et al. 1982, Bisson et al. 1987). Refer to reviews by Bisson et al. (1987), Maser et al. (1988), and Naiman et al. (1992) for more detail role and function of large wood. Wood enters streams inhabited by fish either directly from the adjacent riparian zone or from upslope tributaries and hillslopes that are accessible to or not inhabited by anadromous fish (Naiman et al. 1992).

Large wood in streams has been reduced because of a variety of past and present-day timber harvesting and associated activities. Buffer zones have been inadequate because they have been too narrow and were vulnerable to windstorms and floods. In addition, harvest and salvage logging operations in buffer zones have further reduced the long-term recruitment of large wood (Bryant 1980, Bisson et al. 1987). Also, the absence of vegetative buffers in tributaries not

inhabited by fish may eliminate sources of large wood for streams inhabited by fish (Naiman et al. 1992). Debris flows and dam-break floods resulting from timber harvest activities may remove large wood from channels and riparian vegetation from streambanks (Benda and Zhang 1990, Swanston 1991) on one portion of a drainage system and deposithis material downstream.

The absence of wood in many streams may also be the legacy of past activities. Mandated cleanup activities removed wood from streams throughout the region of the northern spotted owl from the 1950's through 1970's (Narver 1971, Bisson and Sedell 1984). Earlier activities such splash-damming networks that stored water to be released to flood streams and transport logs, also removed large amounts of wood from streams (SedelI and Luchessa I982, Sedell et al. I991).

Habitat Complexity - A primary factor influencing the diversity of stream fish communities is habitat complexity. Attributes of habitat complexity include the variety and range of hydraulic conditions (i.e., depths and water velocities) (Kaufmann 1987), number of pieces and of wood (Bisson et al. 1987), the types and frequency of habitat units, and the variety substrates (Sullivan et al. 1987). More complex habitats support more diverse assemblages and communities (Gorman and Karr 1978, Schlosser 1982, Angermeier and Karr 1984). Habitat diversity can also mediate biotic interactions such as competition (Kalleberg 1958; Hartman 1965) and predation (Crowder and Cooper 1982; Schlosser 1988).

Habitat simplification may result from timber harvest activities (Bisson and Sedell 1984; Hicks et al. 1991; Bisson et al. 1992; Frissel 1992; Ralph et al. unpub.). Timber harvest activities can result in a decrease in the number and quality of pools (Sullivan et al. 1987). Wood is a major habitgt forming element in streams. Reduction of wood in the channel, either from present or past activities, generally reduces pool quantity and quality (House and Boehne 1987, Bisson et al. 1987). Constricting naturally unconfined channels with bridge approaches or streamside roads (Furniss et al. 1991) reducestream meandering, and decreases pools formed by stream meanders that undercut banks. Influxes of sediment from increased mass failures of roads (Megahan and Kidd 1972, Morrison 1975, Swanson and Dyrness 1975, Swanson et al. 1981, Ketcheson and Froehlich 1978, Marion 1981, Megahan et al. 1992, Coats I987, Janda et al. 1975, Kelsey et al. I981, Madej 1984, Beschta I978, Nolan and Marron I985) and from increased mass failures following harvest on unstable slopes (Morrison 1975, Swanson and Dyrness 1975, Swanson et al. 1981, Ziemer and Swanston 1977, Ketcheson and Froehlich 1978, Marion 1981, Grant and Wolff 1991, Coats 1987, Janda et al. 1975, Kelsey et al. 1981, Madej 1984, Nolan and Marron 1985) can result in the loss of pools

In Pacific Northwest streams, habitat simplification resulting from timber harvest and associated activities leads to a decrease in the diversity of the anadromous salmonid complex (Bisson and Sedell 1984, Li et al. 1987, Hicks 1990, Reeves et al., in press). One fish species may increase in abundance and dominance while others decrease. Holtby (1988), Holtby and Scrivener (1989), and Scrivener and Brownlee (1989) in British Columbia and Rutherford et al. (1987) Oklahoma reported similar responses by fish communities in streams affected by timber harvest activities. Similar patterns have also been observed in streams altered by other anthropogenic activities such as agriculture (Schlosser 1982, Berkman and Rabini 1987) and urbanization (Leidy 1984, Scott et al. 1986).

Water Temperature - Increase water temperature can often be traced to removal of shade-producing riparian vegetation along fish-bearing streams and along smaller tributary streams that supply cold water to fish bearing streams (Beschta et al. 1987, Bisson et al. 1987). Removal of streambank vegetation has resulted largely from timber harvest in riparian areas (Beschta et al. 1987).

Changes in the water temperature regime can affect the survival and production of anadromous salmonids, even when temperatures are below levels considered to be lethal. For example, Reeves et al. (1987) found that interspecific competition between redside shiners (*Richardsonius balteatus*) and juvenile steelhead was influenced by water temperature; trout dominated at temperatures (<68°F) and shiners at temperatures (>68°F). In Carnation Creek, British Columbia, water temperatures during both summer and winter changed because of timber harvest activities. The consequence of this was accelerated growth and earlier migration of juveniles (Holtby 1988). However, Holtby speculated that survival of coho salmon to adults would decrease because of the earlier time of ocean entry. Berman and Quinn (1991) found that fecundity and variability of eggs of spring chinook salmon were affected by elevated water temperatures.

Sediments - Increased levels of sediment can have negative impacts on anadromous fish and their habitat. Developing eggs and embryos of anadromous salmonids generally require gravel with <20 percent fines, which may vary in size from silt to sand (Bjornn and Reiser 1991). Survival of developing eggs and alevins decreases as the levels of fines increase (Cederholm and Reid 1987, Chapman 1988, Scrivener and Brownlee 1989, Everest et al. 1987, Bjornn and Reiser 1991). Also, fine sediment that is deposited or in suspension can reduce primary production and benthic invertebrate abundance (Cordane and Kelly 1961, Lloyd et al. 1987). This can reduce food availability for fish.

Increased sediments in streams can be a result of timber harvest and associated activities. Infilling of spawning gravel by fine sediments may result from accelerated erosion of road surfaces and by road failures (Megahan and Kidd 1972, Morrison 1975, Swanson and Dyrness 1975, Swanson et al. 1981, Ketcheson and Froehlich 1978, Marion 1981, Furniss et al. 1991, Megahan et al. 1992, Coats et al. 1985, Janda et al. 1975, Kelsey et al. 1981, Madej 1984, Nolan and Marron 1985, Cederholm and Reid 1987). Slope failures following harvest on unstable slopes may also result in increased levels of sediment (O'Loughlin 1972, Megahan and Kidd 1972, Morrison 1975, Swanson and Dyrness 1975, Swanson et al. 1981, Ziemer and Swanston 1977, Ketcheson and Froehlich 1978, Marion 1981, Megahan et al. 1992, Scrivener and Brownlee 1989).

Rate of Habitat Recovery - Recent work by Hicks (1990) and Bilby and Ward (1991) suggest that habitat is slow to recover to pre-harvest levels of complexity. Schwartz (1991) found that cutthroat trout populations in streams with coho salmon failed to recover to pre-timber harvest levels 25 years after harvest. Gurtz and Wallace (1984) believed that timber harvest has analogue in the natural disturbance regime and therefore, some organisms may not have evolved an appropriate response to it. Yount and Niemi (1990) classified timber harvest as a "press disturbance". This suggests a differential response of species to the disturbance and the system may not recover to pre-disturbance states, due to the loss or alteration of functions and processes affecting the system.

Alteration of ecological processes and environmental conditions may affect several levels of ecological organization. Individual and population responses may vary depending on the magnitude and duration of the impact, species-specific requirements (Kelly and Harwell 1990, Yount and Niemi 1990), and the presence of refugia (Sedell et al. 1990). Because of variability in response by individuals and populations, members of a community are unlikely to exhibit a uniform response to disturbance or environmental alteration. The effect of disturbance on communities depends, in part, on the combined effect on both individuals and populations as well as the extento which processes that influence the structure and composition of communities are altered (e.g., Reeves et al. 1987, Baltz et al. 1982).

CONSERVATION STRATEGY FOR FISH HABITAT IN NATIONAL FORESTS WITHIN THE RANGE OF THE NORTHERN SPOTTED OWL

In keeping with the principles and information presented in the previous sections, we have developed a conservation strategy for fish habitat in National Forests within the range of the northern spotted owl. The strategy is designed to provide a high probability for mMntaining and restoring habitat for fish. Its focus is on maintaining and restoring ecological functions and processes that operate in a watershed to create habitat. We believe this type of approach is both prudent and necessary given the current perilous state of many native fish stocks of salmon and trout (Nehlsen et al. 1991, Higgins et al. 1992, USDI 1992), resident fish (Williams et al. 1989, USDI 1992), and other riparian dependent organisms (USDI 1992, Chapter 5 of this report) found on Federally managed lands within the range of the northern spotted owl.

This conservation strategy is a slightly modified version of one of 8 scenarios for managing anadromous salmonid habitat in National Forests in Idaho, Oregon, Washington, California, and Alaska evaluated as part of the Forest Service's Pacific Salmon Workgroup and Field Team (hereafter referred to as the Pacific Salmon Workgroup, also known as "PacFish") (USDA 1992a). This strategy is not a modification in substance or content of the selected Pacific Salmon Workgroup alternative but in the geographic areas to which the alternative applies. The Pacific Salmon Workgroup is only concerned with anadromous salmonids. The present effort includes portions of two National Forests that do not have anadromous salmonids, the Deschutes and Winema National Forests, However, we believe that the strategy presented here is applicable for management of aquatic habitats on these lands. Both of these National Forests have populations of bull trout, which is currently being considered for threatened and endangered status, primarily because of the degradation and loss of its habitat.

The Scientific Analysis Team was not asked to develop a set of management alternatives as was done for the Pacific Salmon Workgroup. The Forest Service will continue to evaluate all alternatives developed by the Pacific Salmon Workgroup independent of the Scientific Analysis Team's effort. The Forest Service may opt to adopt or implement another management strategy which could have a lower or higher probability of maintaining and restoring aquatic habitat. Regardless of the Forest Service's decision upon completion of the Pacific Salmon Workgroup's Management Strategy for Pacific Salmon and Steelhead Habitat, the content and assessment of the conservation strategy for habitat of fish proposed by the Scientific Analysis Team will not change.

In this section the scientific rationale for the proposed conservation strategy is set forth and the specific elements of that strategy are described.

Rationale and Basis for Conservation Strategy

The approach we have taken in developing our recommended conservation strategy for fish differs from comparable strategies for other organisms. Reasons for this rest primarily with the unique biological requirements of, and scientific uncertainties associated with, anadromous fish. Unlike other organisms whose habitat requirements may be well-defined and understood, anadromous fish occupy a range of habitats over large areas because of their life histories, environmental conditions, and interspecific interactions (Bisson et al. 1992). Over the course of its life, individual fish may hatch in a headwater stream, rear in a lower-gradient alluvial reach, pass through an estuary on the way to the ocean, only to reoccupy many of the same habitats upon returning to spawn. The freshwater component of their life histories thus plays out over a grand scale that may span several hundred miles of river networks set within a landscape of many thousand square miles. Any conservation strategy to protect and restore fish habitat must take this scale into account.

A second factor is that the current level of scientific understanding of fish habitat relationships does not allow us to define specific habitat requirements for fish throughout their life cycle at the watershed level. The general habitat needs of fish are well known (i.e., deep resting pools, cover, certain temperature ranges, clean gravels for spawning)(Bjornn and Reiser 1991). However, we cannot specify how these habitats and conditions should be distributed through time and space to provide for fish needs. Our understanding of fish habitat requirements is largely based on laboratory and site-specific studies that typically examine a single requirement for a single species at one point in its life cycle at a time. In natural watersheds, however, the different species and age:classes interact with multiple habitat elements in complex ways. This interaction occurs within a landscape where the quality and distribution of habitat elements change with time in relation to disturbance processes and land use-imposed changes on streams and riparian zones.

There is the need to address fish habitat at a broad landscape scale. In addition, there is limited knowledge about how habitat should be distributed over a watershed through time. Consequently, we have not adopted a strategy of delineating specific watersheds with explicit standards for habitat elements. Rather, we have focused our efforts on developing a landscape-wide strategy that seeks to retain, restore, and protect those processes and landforms that contribute habitat elements to streams and promote good habitat conditions for fish and other riparian-dependent organisms. We have attempted to develop a conservation strategy that is aimed at restoring and maintaining the ecological health of watersheds (Karr et el. 1986, Kerr 1991, Naiman et el. 1992). At the heart of this approach is a recognition that fish and other aquatic organisms have evolved within a dynamic environment that has been constantly influenced and changed by geomorphic and ecologic disturbances. Good stewardship of aquatic resources requires that land use activities not alter this disturbance regime beyond the range of conditions to which these organisms have become adapted.

The disturbance regime of watersheds in the Pacific Northwest includes both geomorphic and non-geomorphic processes, important geomorphic processes include mass movements (i.e., debris slides, debris flows, deep-seated landslides), peak stream flows, bank erosion, dam-break floods, and ice rafting (Swanston 1991). Non-geomorphic processes include fire, windstorms, and vegetation mortality due to disease and insects. These processes influence the input rate, quantity, quality, and movement of water, sediment, nutrients and wood through streams. It is the interaction of these elements with the channel and surrounding riparian zone that determines the abundance and quality of fish habitat within watersheds. Habitat degradation occurs where a

change in the character of disturbance processes, such as in their frequency, duration, magnitude, severity, or legacy of physical structure, pushes this interaction outside the range of conditions to which fish have evolved. Most of the habitat degradation caused by human activities is due to increasing the frequency or magnitude of disturbances (i.e., landslides and debris flows [Swanston and Swanson 1976]), or decreasing the physical legacy of disturbances (e.g., by reducing the quantity or quality of large woody debris delivered to channels by landslides and debris flows [Naiman et al. 1992]).

Our strategy is to maintain as close to a "natural" disturbance regime as is possible within watersheds and landscapes, many of which have already been altered by human activities. We recognize that disturbances are essential to maintain good aquatic habitat. Typically, elements that physically create this habitat (i.e., boulders, large wood, gravel) are contributed to streams by episodic events (Naiman et al. 1992). However, the rate at which these episodic disturbances occur should not be significantly increased due to human activities. And, when these disturbances do occur, they retain all of the elements necessary to create high quality habitat.

Doing this requires several approaches. Land-use activities need to be limited or excluded in parts of the landscape prone to geomorphic disturbances, such as mass movements or bank erosion. The distribution of land use activities, such as clearcuts or roads, needs to be analyzed to ensure that peak streamflows are not being increased. Headwater riparian zones need to be protected, so that when debris slides and flows occur, they contain large wood and boulders necessary for creating habitat further downstream. Riparian zones along larger channels need protection to limit bank erosion due to trampling, grazing, and compaction, to ensure an adequate and continuous supply of large wood to channels, and to provide shade and microclimate protection.

The approach we have taken is designed to accomplish these objectives. It needs to be emphasized, however, that it will require time for this strategy to work. Because it is based on natural disturbance processes, it may require timescales of decades to over a century to accomplish all of its objectives. Significant improvements in fish habitat, however, can be expected on the timescale of 10 to 20 years. Equally important, however, is that this strategy will protect existing good habitat from degradation. This is particularly true since this approach seeks to maintain and restore habitat over broad landscapes as opposed to individual projects or small watersheds. We believe that if this approach is conscientiously implemented and applied, it will provide protection for habitat for fish and other riparian-dependent species resources and restore currently degraded habitats.

RIPARIAN MANAGEMENT OBJECTIVES

Riparian and aquatic ecosystems are physical-biological systems in or near surface waters that have primary values associated with water and the proximity of land to water (Gregory et al. 1991). These ecosystems include terrestrial, semi-aquatic (land/water interface), and aquatic components and habitats. To manage ecosystems, it is crucial to analyze the whole system by pulling individual system components together and then evaluating all important influences, interconnections, and interactions (Naiman et al. 1992).

Riparian and aquatic ecosystems in National Forests within the range of the northern spotted owl will be managed to achieve the following specific riparian objectives:

1. Maintain or restore water quality to a degree that provides for stable and productive riparian and aquatic ecosystems. "Water quality parameters that apply to these ecosystems include timing and character of temperature, sediment, and nutrients.

2. Maintain or restore the stream channel integrity, channel processes, and sediment regime under which the riparian and aquatic ecosystems developed. Elements of the sediment regime include the timing, volume~ and character of sediment input and transport.

3. Maintain or restore instream flows to support desired riparian and aquatic habitats, the stability and effective function of stream channels, and the ability to route flood discharges.

4. Maintain or restore the natural timing and variability of the water table elevation in meadows and wetlands.

5. Maintain or restore the diversity and productivity of native and desired non-native plant communities in riparian zones.

6. Maintain or restore riparian vegetation to provide an amount and distribution of large woody debris characteristic of natural aquatic and riparian ecosystems.

7. Maintain or restore habitat to support populations of well-distributed native and desired non-native plant, vertebrate, and invertebrate populations that contribute to the viability of riparian-dependent communities.

8. Maintain or restore riparian vegetation to provide adequate summer and winter thermal regulation within the riparian and aquatic zones.

9. Maintain or restore riparian vegetation to help achieve rates of surface erosion, bank erosion, and channel migration characteristic of those under which the desired communities developed.

10. Maintain and restore riparian and aquatic habitats necessary to foster the unique genetic fish stocks that evolved within that specific geo-climatic ecoregion.

Components of the Fish Habitat Conservation Strategy

The Fish Habitat Conservation Strategy is designed to conserve and restore habitat for at-risk stocks of anadromous salmonids and resident fish in National Forests within the range of the northern spotted owl. It rests on four critical components: (1) identifying a landscape-level system of watershed refugia located on lands managed by the Forest Service within the range of the northern spotted owl; (2) establishing Riparian Habitat Conservation Areas for individual watersheds where land-use activities are restricted to those that either directly benefit or do not diversely affect fish habitat; (3) implementing watershed analysis as an explicit level of planning designed to evaluate geomorphic and ecologic processes operating in specific watersheds, identify boundaries of Riparian Habitat Conservation Areas, and provide a blueprint for restoration measures; and (4) initiating comprehensive watershed restoration measures on watersheds, with

priority given to those having the greatest potential to provide high quality fish habitat. Each element addresses a critical aspect for maintaining and restoring fish habitat and ecological functions in streams. They are designed to act as a comprehensive package and will not achieve desired results if implemented alone or in some limited combination.

Component 1 - Designated Lands Providing Habitat Protection - Refugia or designated areas providing high quality fish habitat, either currently or in the future, are a cornerstone of most species conservation strategies. Refugiare habitats or environmental factors that convey protection to biotic communities at different temporal and spatial scales. Examples of aquatic refugia range from clean gravels at the particle scale, to well vegetated floodplains and side channels at the channel reach scale, to the condition of the whole watershed at the watershed scale (Sedell et al. 1990). In a review of case histories of recovery of aquatic systems following disturbance, Yount and Niemi (1990) and Niemi et al. (1990) found considerable evidence the existence of spatial refugia-undisturbed habitats providing a source of colonists to adjacent areas-was critical to enable recovery of degraded systems. In stream systems where disturbance was widespread and no accessible refugia remained, biological recovery was delayed or entirely precluded.

At a minimum, refugia need to be considered at a watershed scale, rather than as fragmented areas of suitable habitat. Sedell et al. (1990), Moyle and Sato (1991), and Williams (1991) discuss several kinds of riverine and hyporheic habitats that can act as refugia, and provide examples of how they may function in the recovery of populations from natural catastrophe and anthropogenic disturbance. Sedell et al. (1990) argue that refugia at the scale of reaches larger tend to be more resistant and resilient to a variety of disturbances. Moyle and Sato (1991) argue that to recover species, refugia should be focused at the watershed scale. Management and restoration strategies that focus on reaches or small segments of a watershed fail to consider the connectivity of stream ecosystems. Naiman et al. (1992), Sheldon (1988), and Williams et (1989) noted that past attempts to recover fish populations have been unsuccessful because the failure to approach the problem from a basin perspective.

Even a system of isolated watersheds acting as refugia may not be sufficient for a regional conservation strategy. Fish stocks at risk are distributed across the entire range of the owl forests. Over its life history, an individual fish will travel through and occupy habitats in a range of watersheds of different sizes. Poor habitat conditions at any point of this journey will reduce chances of survival. Sheldon (1988) believed that 3rd-5th order watersheds should be the cornerstone of watershed-level recovery efforts for fish in general. This is likely an appropriate minimum size range for anadromous, and resident fish. Planning for habitat protection and restoration needs to include watersheds at the scale of about 100,000 acres (e.g., South Fork Umpqua River).

Watersheds that serve as refugia are crucial for maintaining and recovering habitat of at-risk stocks of anadromous salmonids and species of resident fish. These refugia should include areas that currently have good habitat as well as areas of degraded habitat. Areas presently in good condition would serve as anchors for the potential recovery of depressed fish stocks. Congressionally designated Wilderness, National Recreation Areas, and other specially designated areas currently contain high quality fish habitat in National Forests within the range of the northern spotted owl, and currently provide habitat for at-risk stocks and species. Habitat Conservation Areas identified for the northern spotted owl also contain some high quality fish habitat. However, less than 25 percent of the area of key watersheds identified by Johnson et al. (1991) were in Habitat Conservation Areas. Additionally, Habitat Conservation Area boundaries

seldom encompass entire watershed boundaries and frequently do not contain an entire stream from headwaters to fish-bearing streams. Although these areas would be the anchors of a watershed refugia system, additional watersheds that currently have low quality habitat would become future sources of good habitat with the implementation of a comprehensive restoration program (Component 4).

A network of key watersheds located in National Forest throughout the range of the northern spotted owl was identified by Johnson et al. (1991) (Figures 5-K-2 through 5-K-4). These watersheds contain at-risk fish species and stocks and either good habitat or if they have habitat that is in a degraded state, have a high restoration potential (Reeves and Sedell 1992). Forest Service fish biologists in northern California have deleted some watersheds that were identified by Johnson et al. (1991) and added others. These changes are reflected in Figure 5-K-2. Under the Fish Habitat Conservation Strategy, key watersheds require a level II Watershed Analysis (Component 3). Key watersheds with poor habitat also receive priority in any restoration program (Component 4).

Establishment of a network of key watersheds is crucial for maintaining and restoring fish habitat in National Forests within the range of the northern spotted owl. In the short-term, identification of basins with good habitat and implementation of the components of this strategy will reduce the potential of future habitat loss or degradation. These areas would not only serve as physical refugia but also as source of individuals for recolonization of degraded areas as they improve. They will also be critical to initiate the restoration of degraded areas because of the extensive amount of habitat that is in poor condition due to the effects of past land-management activities. Key watersheds that currently contain poor habitat are believed to have the best opportunity for success.

The network of key watersheds, although crucial, will not be sufficient to assure the recovery of at-risk fish stocks. Key watersheds are important because they contain at-risk fish stocks and the best habitat or potential habitat. It is important, however, to limit those land-use activities that aredestructive to fish and associated riparian-dependent species in all National Forests, whether in a key watershed or not. Riparian Habitat Conservation Areas must be established in all National Forests within the range of the northern spotted owl.

Component 2 - Riparian Habitat Conservation Areas - For Forest Service streams and lands to function as refugia, special considerations need to apply to those parts of watersheds which directly contribute to creating or maintaining aquatic habitat. Riparian Habitat Conservation Areas are portions of watersheds where riparian-dependent resources receive primary emphasis and where special standards and guidelines apply. Riparian Habitat Conservation Areas encompass those portions of a watershed that are directly coupled to streams and rivers, that is, the portions of a watershed required for maintaining hydrologic, geomorphic, and ecologic processes that directly affect streams, stream processes, and fish habitats. Riparian Habitat Conservation Areas include not only the more common Land and Resource Management Plan-designated riparian management zones or streamside management zones adjacent to rivers, streams, springs, seeps, wetlands, and marshes but also includes primary source areas for wood and sediment such as landslides and landslide-prone slopes in headwater areas and along streams. Riparian Habitat Conservation Areas generally parallel the stream network but also include other areas necessary for maintaining hydrologic, geomorphic, and ecologic processes (Figure 5-K-5). Every watershed in National Forests within the range of the northern spotted owl will have Riparian Habitat Conservation Areas.

Establishment of Riparian Habitat Conservation Areas will confer benefits to riparian dependent and associated species other than fish. It will enhance habitat conservation for organisms that are dependent on the transition zone between upslope and riparian areas. For example, many amphibians depend on wood created habitat in headwater streams (Bury et al. 1991, Chapter this document). Improved travel and dispersal corridors for many terrestrial animals and plants and a greater connectivity of the watershed should also result from delineation of Riparian Habitat Conservation Areas.
Final boundaries of the Riparian Habitat Conservation Area in a watershed are determined by watershed analysis (Component 3). However, we have established a set of interim widths of Riparian Habitat Conservation Areas for M1 watersheds that will apply until the watershed analysis has been completed. The widths are designed to provide what we believe is a full measure of fish habitat and riparian protection until this analysis can be completed.

a. Inerim Widths of Riparian Habitat Conservation Areas for Different Water Bodies

Interim widths of Riparian Habitat Conservation Areas vary with type of water body. They are defined as: 1) fish-bearing streams; 2) non-fish-bearing streams; 3) lakes; 4) ponds, reservoirs, and wetlands; and 5) other seasonally flowing or intermittent, streams. Streams in the last category may have little effect on fish habitat individually, but are collectively essential for maintaining processes that affect fish habitat. The last category also includes hydrologically, geomorphically, and ecologically significant areas such as landslides and landslide-prone areas, springs, seeps, marshes, and wetlands.

Several factors were considered in establishing interim widths of Riparian Habitat Conservation Areas for each stream type. One was how the various geomorphic and ecologic functions provided by riparian areas change with distance from the stream and with stream size. Key riparian processes considered in developing widths included sources of input of large and small woody debris and litter, shading, and buffering streams from the effcts of strong winds and otherr microclimatic fluctuations (Gregory et al. 1991). We also considered the roles of vegetated and undisturbed floodplains in maintaining functioning side channels (used by fish for overwintering and refugia during peak flows) and hyporheic zones (which may supply cool or nutrient-rich groundwater during summer months) (.Naiman et ai. 1992). Additionally, considered the use of Riparian Habitat Conservation Areas as breeding and rearing areas and dispersion corridors for organisms other than fish (Gregory et ai. 1991, Gomez 1992).

Riparian areas contain a wide range of conditions along streams, lakes, springs, and wetlands. These include wide floodplains, narrower canyon reaches, multiple stream channels, and a diverse array of species and age-classes of vegetation. Many of these features are influenced by natural and anthropogenic disturbances (Grant 1986, Naiman et ai. 1992). Boundaries of riparian areas are highly variable and irregular as a result of the natural character of the landscape and the local disturbance history. This variability and irregularity must be taken into account when planning land-management activities.

Physical features of streams vary widely with stream size. Inner gorges and floodplains are common in streams in National Forests within the range of the northern spotted owl. Inner gorges consist of the steep slopes immediately adjacent to a stream or river channel or floodplain and extend to the first significant break in slope. Widths of inner gorges on permanently

flowing streams vary from 25 to 450 feet (M. Furniss, Six Pdvers National Forest, personnel communication). Widths of the 100 year floodplains for permanently flowing streams vary from 50 to 800 feet in National Forests within the range of the northern spotted owl (Gregory and Ashkenas 1990).

An intact riparian forest in inner gorges and on 100-year floodplains is crucial for creating and maintaining habitat for fish and other riparian-dependent species (Gregory et al. 1991, Naiman et al. 1992). Riparian areas contribute wood and sediment to inner gorge areas. In smaller streams, the wood creates breaks in the channel gradient and forms pools for fish and other aquatic organisms. The wood also creates area of storage for sediment and organic material, which is a major energy source for organisms used as food by fish and other aquatic organisms (Bisson et al. 1987, Bilby and Ward 1991). Inner gorges may also be source areas of wood, sediments, and nutrients for wider floodplain areas located downstream (Gregory et al. 1991, Naiman et al. 1992)

Intact forests on floodplains are sources of large wood and provide refugia for aquatic organisms during floods (Naiman et al. 1992). Wood in these areas helps form habitat (Bisson et al. 1987), creates complexity (such as ranges of water velocities (Kaufmann 1987), and sites of material storage and nutrient processing (Bisson et al. 1987). Riparian vegetation in these areas may also influence the effect of flood events on the channel (Grant 1986, Sedell and Beschta 1991).

Several important processes and functions that influence the stream channel occur within 200 feet of the channel. McDade et al. (1990) and Van Sickle and Gregory (1990) reported that percent of the wood in streams originated in this area. Stream bank stability is achieved within a distance equivalent to 0.5 to 1 site-potential tree height, which is generally within 200 feet of the channel (Sedell and Beschta 1991). Litter fall, nutrient retention and input (Gregory et al. 1987) and shade functions (Beschta et al. 1987) also generally occur within 100-200 feet of the channel.

Several studies (Steinblums 1977, Franklin et al. 1981, Heimann 1988, Andrus et al. 1988, Ursitti 1991, and Morman 1993) have found the basal area of conifers, which reflects the size and number of trees present, to be less in riparian areas of second-growth forests than in late-successional and old-growth forests. Riparian stands in late-successional and old-growth forests contain approximately 300 feet 2 per acre of basal area of conifers. This is less than the basal area of conifers found in upslope areas of the same forest (Gregory and Ashkenas 1990, Long 1987). Riparian areas in second-growth forests <80 years old generally have less than 100 $feet^2$ per acre. Riparian areas in second-growth forests 80 to 140 years old contain slightly more than 100 $feet^2$ of basal area of conifers.

Maintenance of riparian forests in late-successional and old-growth forests and restoration in second-growth forests will depend on regeneration rates of conifers in the future. Regeneration of conifers in the riparian zones of natural stands is dependent, at least in part, on downed large trees. Researchers at the Pacific Northwest Research Station, Corvallis, Oregon found that more than 80 percent of conifer regeneration in the riparian zones along coastal Oregon streams that they studied occurred on down logs. The role of nurse trees in forest regeneration in the Pacific Northwest is widely recognized (Harmon et al. 1986). in riparian zones, nurse trees originate within 0 to 400 feet of the active channel. Greater retention of live trees and snags in riparian stands and adjacent upslope source areas will enhance the generation of future riparian forests.

Microclimate variability within riparian zones may be influenced by the condition of upslope stands. Chen (1991) and Chen et al. (in press) found that air temperatures in old-growth Douglas-fir stands were altered by the effects of surrounding clearcuts. Air temperatures were altered from 180 to 360 feet (i.e., 1 to 2 tree heights) from the edge. Wind velocities were altered up to 5 tree heights. Raynor (1971) found velocites altered up to 8 tree heights. Fritschen et al. (1970) reported that the microclimate of young forest stands (i.e., 40 to 60 years old) was altered up to 400 feet from the edge of a cut. While all of these values were measures for upland forests, they probably reflect the edge effects of dear-cuts on the micro-climate of adjacent riparian forests. The greater the widths of Riparian Habitat Conservation Areas the more stable will be the microclimate within riparian forests.

The abundance of amphibians in Pacific Northwest forest and riparian zones is influenced by habitat conditions in riparian areas (Bury et al. 1991, Gomez 1992). Amphibians populations are generally found less than 900 feet from water sources (Nussbaum et al. 1983). Gomez (1992) found that rough-skinned newts, tailed frogs, and western redbacked salamanders were the most abundant species of herptafauna in upland and riparian areas along the Oregon Coast Range. These organisms were found up to 600 feet from streams but were most abundant within 300 feet. Many species have specific tolerance thresholds (e.g., temperature and moisture) microhabitat requirements (e.g., headwater seeps or talus slopes). Many also require downed wood, but may differ in types of wood (e.g., snag, bark on a log, or bark on the ground) or particular decay class of wood (refer to Chapter 5 more specific requirements of specific species). Alteration of microhabitat climate may influence the suitability of riparian conditions for riparian-dependent organisms.

Many mammal populations are also dependent on riparian areas. Doyle (1986 and 1990) found that riparian areas in old-growth forests in the Cascades of Oregon were source areas for upland small mammal populations. Abundance of small mammals in coastal forests of Oregon were greatest within 300 feet of the stream, even though individuals were found up to 600 feet away (Gomez 1992). Chapter 5 of this document and USDI (1992) identify several mammal species that use or are dependent on riparian zones. Riparian corridors may also be important as dispersal, travel, and migratory routes for mammals (Gregory et al. 1991). The size (and limits on activities within) Riparian Habitat Conservation Areas should create a variety of microclimate and habitat conditions required by the large number of riparian-dependent organisms. This in turn should potentially accommodate a diverse assemblage of riparian-dependent organisms.

A riparian buffer zone is bordered by two edges; one is the stream and the other the adjacent upslope area. Each side is subjected to different sets of disturbances. If harvested, the upland side of the riparian forest is subjected to increased mortality from blowdown and increased stress resulting from more variable air temperatures and altered rates of evapotranspiration. The consequence of the latter factors is increased susceptibility to insect and disease (Geiger 1965, Caruso 1973, Ranney 1977, Wagner 1980). On the stream side, the stream can influence the microclimate of the riparian forest. The wider the stream, the greater the edge effect in terms of temperature and wind exposure. Additionally, the riparian forest is influenced by flood events and natural movements of the stream channel across the floodplain. The persistence of a riparian forest area is related to its length and width, due to mortality caused on both edges.

We believe that the character of any conservation program for maintaining and restoring habitat for at-risk stocks of anadromous salmonids and species of resident fish must maintain ecosystem functions and processes to have a high probability of success. A program of this nature is necessitated by the large number of fish stocks at risk (112) and the overall poor conditions

habitat and aquatic ecosystems in National Forests in the range of the northern spotted owl. We believe that it is prudent and justified to require Riparian Habitat Conservation Areas widths to incorporate areas larger than traditional riparian management areas, at least in the interim until a watershed analysis is completed.

Maintaining the connectivity of the aquatic ecosystem is necessary for healthy watersheds and good fish habitat (Naiman et al. 1992). First and 2nd-order streams, which generally include the permanently flowing non-fish bearing streams and seasonally flowing or intermittent streams, may represent over 70 percent of the cumulative channel length in mountain watersheds in the Pacific Northwest (Benda et al. 1992). These streams are sources of water, nutrients, wood and other vegetative material for streams inhabited by fish and other aquatic organisms (Swanson et al. 1981, Benda and Zhang 1990, Vannotet al. 1980). Decoupling the stream network can result in the disruption and loss of functions and processes necessary for creating and maintaining fish habitat. The Riparian Habitat Conservation Area widths specified for the different stream and wetland types were developed to maintain connections in watersheds that are currently in good condition and to initiate recovery of the connections in degraded areas.

Based on these criteria, we identify five types of streams or water-bodies and define interim widths of Riparian Habitat Conservation Areas for each:

1. Fish-bearing Streams: The Riparian Habitat Conservation Area consists of the stream and the area on either side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of two site-potential trees, or 300 feet horizontal distance (600 feet, including both sides of the stream channel), whichever is greatest.

   The first 200 feet of the Riparian Habitat Conservation Area recognizes the adjacent land as a source of shade, large wood, detritus, and water of favorable temperature. The last 100 feet will serve to maintain microclimate and to protect the first 200 feet from fire and wind damage and help ensure that the integrity of the functional Riparian Habitat Conservation Area survives over the long-term to benefit fish habitat and riparian dependent species.

2. Permanently Flowing Non-fish-bearing Streams: The Riparian Habitat Conservation Area consists of the stream and the area on either side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of one site-potential tree, or 150 feet horizontal distance (300 feet, including both sides of the stream channel), whichever is greatest.

3. Lakes: The Riparian Habitat Conservation Area consists of the body of water and the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or to the extent of moderately and highly unstable areas, or to a distance equal to the height of two site-potential trees, or 300 feet horizontal distance, whichever is greatest.

Ponds, Reservoirs, and Wetlands Greater Than One Acre: The Riparian Habitat Conservation Area consists of the body of water (the maximum pool elevation of reservoirs) or wetland and the area to the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or to the extent of moderately and highly unstable areas, or to a distance equal to the height of one site-potential tree, or 150 feet horizontal distance, whichever is greatest.

Seasonally Flowing or Intermittent Streams, Wetlands Less Than One Acre, Landslides, and Landslide-Prone Areas: This category applies to riparian ecosystems with high variability in size and site-specific characteristics. The Riparian Habitat Conservation Area consists of the stream channel or wetland and the area from the edges of the stream channel or wetland to the top of the inner gorge, or to the outer edges of the riparian vegetation, or to the extent of landslides or landslide-prone areas, or to a distance equal to the height of one site-potential tree, or 100 feet horizontal distance (200 feet, including both sides of the channel), whichever greatest.

We believe that the interim widths of the Riparian Habitat Conservation Areas will provide protection for riparian forests and maintain ecological functions and processes necessary for the creation and maintenance of habitat for fish and other-riparian dependent organisms. Existing data could be used to argue for wider Riparian Habitat Conservation Area widths, at least in certain stream categories. However, the interim widths will fully protect ecologically important areas within a watershed, such as floodplains. Interim Riparian Habitat Conservation Areas will also be able to survive some mortality in the short-run and still maintain its ecological integrity.

We emphasize that Riparian Habitat Conservation Area widths are applied to all streams in National Forests within the range of the northern spotted owl until a watershed analysis has been completed, if watershed analysis finds that because of the characteristics of a given site, narrower or wider Riparian Habitat Conservation Areas would provide the better function than the interim Riparian Habitat Conservation Area, then the Riparian Habitat Conservation Area width could be changed, and any allowable management activities would be adjusted to reflect these new Riparian Habitat Conservation Area dimensions.

A conceptual example of a Riparian Habitat Conservation Area is shown in Figure 5-K-5. This watershed is characterized by a stream drainage network that consists of a major fish-bearing stream, several fish-bearing tributaries, and some non-fish-bearing intermittent tributaries. The watershed also contains a marshy area near the watershed outlet, a large, inactive landslide, and many landslide-prone areas in steep terrain near the watershed boundary. The Riparian Habitat Conservation Area extends around and includes all these features.

b. Standards and Guidelines for Riparian Habitat Conservation Areas

Developing prescriptions for improving anadromous fish habitats includes formulating standards and guidelines that address the types of management activities that are allowed in Riparian Habitat Conservation Areas. In general, these standards and "defines prohibit activities in Riparian Habitat Conservation Areas that are not designed specifically to improve the structure and function of the Riparian Habitat Conservation Area and benefit fish habitat. Management activities in Riparian Habitat Conservation Areas must contribute to improving or maintaining watershed and aquatic habitat conditions described in the Riparian Management Objectives. When activities are found to detract from meeting the Riparian Management Objectives, those

activities will be modified, rescheduled, or discontinued. Further, for areas where riparian conditions are presently degraded, management activities must be designed to improve habitat conditions.

The standards and guidelines that follow are not all-inclusive. Watershed and riparian area management on lands managed by the Forest Service is guided by a variety of direction, including Best Management Practices, Land and Resource Management Plans, Forest Service manuals and handbooks, and other plans and directives. For the lands contained within the Riparian Habitat Conservation Area, these standards and guidelines supersede other direction, unless the conflicting standard or direction affords greater protection to riparian and fish habitat values and better foster attainment of the Riparian Management Objectives.

Timber Management

TM-1. Prohibit scheduled timber harvest, including fuelwood cutting, in Riparian Habitat Conservation Areas. Allow unscheduled harvest only as described in TM-2 and TM-3.

TM-2. Where catastrophic events such as fire, flooding, volcanic eruptions, severe winds, or insect or disease damage result in degraded riparian conditions, allow unscheduled timber harvest (salvage and fuelwood cutting) to attain Riparian Management Objectives. Remove salvage trees only when site-specific analysis by an interdisciplinary team determines that present and future woody debris needs are met and other Riparian Management Objectives are not adversely affected.

TM-3. Design silvicultural prescriptions for Riparian Habitat Conservation Areas and allow unscheduled harvest to control stocking, reestablish and culture stands, and acquire desired vegetation characteristics needed to attain Riparian Management Objectives.

Roads Management

RF-1. Keep road and landing construction in Riparian Habitat Conservation Areas to a minimum. No new roads or landings will be constructed in Riparian Habitat Conservation Areas until watershed, transportation, and geotechnical analyses are completed. Appropriate standards for road construction, maintenance, and operations will be developed from this analysis to ensure that Riparian Management Objectives are met. Valley bottom and mid-slope road locations may be used only when this analysis indicates that roads can be constructed and maintained in these locations and meet Riparian Management Objectives.

RF-2. Require that all roads on lands managed by the Forest Service, including those operated by others, are maintained and operated in a manner consistent with the planned uses and with meeting Riparian Management Objectives.

RF-3. Inventory and evaluate all existing roads in Riparian Habitat Conservation Areas. Through an interdisciplinary team review process, determine the influence of each road upon the Riparian Management Objectives. Roads that are found to pose a substantial risk to riparian conditions will be improved or obliterated. Priority will based on the potential impact to riparian resources, the ecological value of the riparian resources affected, and the need for each road. Roads not needed for future

management activities will be closed, obliterated, and stabilized. All obliteration work will meet Riparian Management Objectives and provide for adequate long-term drainage and stability.

RF-4. Inventory and evaluate all existing culverts and stream crossings to identify those that present a risk to meeting Riparian Management Objectives. Culverts and stream crossings found to pose a substantial risk to riparian conditions will be improved to accommodate at least a 100-year flood, including associated bedload and debris. Priorities for upgrading will be based on the potential impact and the ecological value of the riparian resources affected. New stream crossings will be designed and constructed to accommodate at least the 100-year flood, including associated bedload and debris. Crossings will be constructed and maintained to prevent diversion of streamfiow out of the channel and down the road in case of crossing failure. In locations found to have a high potential for failure, the roadway surface and fills will be hardened to further lessen the chance of roadway failure or severe erosion should the crossing over-top.

RF-5. Locate, design, construct, maintain, and operate roads to minimize disruption to natural hydrologic flow paths. This includes road-related activities that would divert stream flow and/or interrupt surface or subsurface flow paths.

RF-6. Apply design, construction, and maintenance procedures to limit sediment delivery to streams from the road surface. Outsloping of the roadway surface is preferred unless outsloping would increase sediment delivery to streams or where outsloping is infeasible. Route road drainage away from potentially unstable channels and hillslopes.

RF-7. Construct, reconstruct, and maintain all road crossings of existing and historic fish-bearing streams to provide for fish passage.

RF-8. Develop and carry out a Road Management Plan that will meet the Riparian Management Objectives. As a minimum, this plan shall include provisions for the following activities:

a) Conduct post-storm inspections of roads known to contribute to degrading the riparian resources. Conductimely maintenance if deficiencies are found.

b) Inspect and maintain all roads providing for passenger car traffic (maintenance levels 3-5) during storms having a predicted high potential to cause problems.

c) Inspect roads providing for high-clearance vehicle use (maintenance level 2) and those dosed, but needed in the future (maintenance level 1), following each storm having a runoff event with a recurrence interval of 1 year or greater. Correct deficiencies that would contribute to degrading riparian resources before the next storm.

d) During annual road maintenance, give high priority to identifying and correcting road drainage problems that contribute to degrading riparian resources.

e) During rainy periods, exclude traffic from roads that do not meet all-weather standards (maintenance levels 2-5).

RF-9. Designate sites to be used as water drafting locations during project-level analysis, or as part of road maintenance for fire management planning. Do not locate drafting sites where instream flows could become limiting to aquatic organisms. During periods of low flow, examine the drafting site and decide if water can continue to be extracted from that site. Design, construct, and maintain water drafting sites so they will not destabilize stream channels or contribute sediment to streams.

RF-10. Prohibit sidecasting of loose material in Riparian Habitat Conservation Areas during construction or maintenance activities.

Grazing Management

GM-1. Promptly adjust grazing practices to eliminate adverse effects of domestic and wild ungulates on riparian resources, if adjusting practices is not effective, eliminate grazing until it is shown that grazing can be reestablished and still attain the Riparian Management Objectives. Establish vegetation reference areas to measure potential site productivity and stream channel morphology that would exist without grazing, and to monitor the status of the ecosystem. Vegetation reference areas are to be located in areas representative of the vegetative community and stream channel types to be managed. Reference areas may include exclusion plots, larger exclosures, or sites with a low disturbance history. In addition to reference areas, conduct systematic monitoring of vegetation status using standardized procedures to determine the effects of grazing on riparian ecosystems and the ability to attain the Riparian Management Objectives.

GM-2. Locate new livestock management and handling facilities outside Riparian Habitat Conservation Areas. For existing livestock management and handling facilities inside the Riparian Habitat Conservation Area that are essential to proper management, apply standards that assure that Riparian Management Objectives are met. Where these objectives cannot be met, require relocation of livestock management and/or handling facilities.

Recreation Management

RM-1. Develop recreation facilities, including trails, within Riparian Habitat Conservation Areas only when such development is compatible with the attainment of Riparian Management Objectives.

RM-2. Monitor the impacts of dispersed or developed recreation in Riparian Habitat Conservation Areas. When Riparian Management Objectives are not being met, reduce impacts through education, use limits, more intensive maintenance, facility

modification, and/or area closures. For example, harassment of fish during spawning or low water can be reduced by dosing access roads or campgrounds during critical periods, or education of users.

RM-3. Coordinate with state agencies to eliminate non-native fish stocking, over fishing, and poaching.

Minerals Management

MM-1. For operations in Riparian Habitat Conservation Areas, ensure that adequate reclamation plans and bonds are included in approved plans of operation. Such plans and bonds must address the costs of removing facilities, equipment, and materials; recontouring disturbed areas to near pre-mining topography; isolating and neutralizing or removing Of toxic or potentially toxic materials; salvaging and replacing topsoil; and preparing seedbed and revegetating to meet Riparian Management Objectives.

MM-2. Avoid locating permanent structures or support facilities within Riparian Habitat Conservation Areas. Road construction will be kept to the minimum necessary for the approved mineral activity. Such roads will be constructed and maintained to meet the Roads Management Standards and to minimize damage to resources in the Riparian Habitat Conservation Area. When a road is no longer required for mineral activity, it will be closed, obliterated, and stabilized.

MM-3. Avoid locating waste dumps in Riparian Habitat Conservation Areas. If no other alternative exists, ensure that safeguards are in place to prevent release or drainage of toxic or other hazardous materials.

MM-4. For leasable minerals, prohibit surface occupancy within Riparian Habitat Conservation Areas for oil, gas, and geothermal exploration and development activities where contracts and leases do not already exist. Where contracts already exist, modify the operating plan to meet the Riparian Management Objectives.

MM-5. Prohibit common variety sand and gravel mining and extraction within Riparian Habitat Conservation Areas (subject to valid permitted rights), unless mining and extraction are consistent with Riparian Management Objectives and needed for restoration purposes.

Fire/Fuels Management

FM-1. Design fuel treatment and fire suppression strategies, practices, and activities to meet Riparian Management Objectives, and to minimize disturbance of riparian ground cover and vegetation. Strategies should recognize the role of fire in ecosystem function and identify those instances where fire management activities could damage long-term ecosystem health.

FM-2. Locate incident bases, camps, helibases, staging areas, helispots and other centers for incident activities outside of Riparian Habitat Conservation Areas. if the only

suitable location for such activities is within the Riparian Habitat Conservation Area, an exemption may be granted following a review and recommendation by a resource advisor. The advisor will prescribe the location, use conditions, and rehabilitation requirements. Use an interdisciplinary team to predetermine suitable incident base and helibase locations.

Prohibit application of chemical retardant, foam, or additives in Riparian Habitat Conservation Areas. An exception may be warranted in situations where over-riding safety imperatives exist, or, following a review and recommendation by a resource advisor, when an escape would cause more long-term damage.

Design prescribed burn projects/prescriptions for areas next to Riparian Habitat Conservation Areas so that Riparian Habitat Conservation Areas are protected. Where riparian ecosystems would be enhanced by use of prescribed fire, clearly identify the specific objectives and risks.

If Riparian Habitat Conservation Areas are significantly damaged by a wildfire or a prescribed fire burning out of prescription, establish an emergency interdisciplinary team to decide the rehabilitation treatments needed.

Use minimum impact suppression methods in Riparian Habitat Conservation Areas. Consider potentially adverse effects of fire suppression effects and the potentially adverse effects of wildfire damage during initial fire size-up, initial suppression response, and in the deve!opment of the Escaped Fire Situation Analysis.

Lands

LH-1. For hydroelectric and other surface water development proposals, require instream flows and habitat conditions that maintain or restore riparian resources, channel conditions, and fish passage at levels that approximate favorable pre-project conditions. Coordinate this process with the appropriate state agencies. During relicensing of hydroelectric projects, make written and timely recommendations to Federal Energy Regulatory Commission that require flows and habitat conditions that maintain/restore riparian resources and channel integrity. Coordinate relicensing projects with the appropriate state agencies.

LH-2. Locate facilities that are not required within the Riparian Habitat Conservation Area (such as control rooms, housing, temporary construction buildings, etc.) outside the Riparian Habitat Conservation Area. Facilities within the Riparian Habitat Conservation Area will be located, operated, and maintained to minimize effects on riparian resources, including, for example, maintenance of upstream and downstream passages, and screening intakes and diversions.

LH-3. Review all Special Use Permits, rights-of-way, and easements affecting Riparian Habitat Conservation Areas. When Riparian Management Objectives are not being met, reduce impacts through education or modification of existing Special Use Permits. When granting easements or other rights-of-way across lands managed by the Forest Service to reach private lands, apply these standards and guidelines

to provide the terms and conditions necessary to protect riparian resources on lands managed by the Forest Service.

LH-4. Use land acquisition and exchange to consolidate in-holdings, with the priority to protect and restore fish stocks and species at risk.

General Riparian Area Management

RA-I. Exclude heavy equipment from Riparian Habitat Conservation Areas, unless specifically approved for road construction and maintenance, or unless an interdisciplinary team finds that proposed activity is needed to meet the Riparian Management Objectives.

RA-2. Fell hazard trees only when they are found to pose an unacceptable safety risk. Such trees may be removed from Riparian Habitat Conservation Areas only when adequate sources of woody debris remain to meet Riparian Management Objectives. If long-term sources of woody debris are inadequate, and a tree is found to pose an unacceptable safety risk, that risk must be reduced in a way that contributes to woody debris objectives.

Watershed and Habitat Restoration

WR-I. A watershed analysis is a prerequisite to planning, implementing, and monitoring all restoration projects. A Level I watershed analysis (see Component 3) may sufficient to identify the causes of riparian area degradation, to set priorities for watershed restoration measures, and initiate restoration projects in critical areas. A full watershed analysis (Level II) is required, however, to develop an integrated basin-wide strategy for restoration and monitoring. Priority should be given to restoring key watersheds supporting at-risk stocks and species.

WR-2. Control the causes of riparian area degradation before initiating restoration projects.

WR-3. Employ restoration methods that promote the long-term genetic and ecological integrity of restored ecosystems.

WR-4. Where mixed ownership exists, encourage the development of Coordinated Resource Management Plans or other cooperative agreements to meet Riparian Management Objectives.

WR-5. Do not use mitigation measures or planned restoration as a substitute for preventing habitat degradation.

Component 3- Watershed Analysis - Watershed analysis is a systematic procedure for characterizing watershed history, processes, landforms, and conditions to meet specific objectives. It is a prerequisite for determining which processes and parts of the landscape affect fish and riparian habitat, and is essential for defining appropriate boundaries for Riparian Habitat Conservation Areas. Watershed analysis forms the basis for evaluating cumulative watershed

effects, defining watershed restoration goals and objectives, implementing restoration strategies, and monitoring the results or effectiveness of all these measures. Watershed analysis employs the perspectives and tools of multiple disciplines, especially geomorphology, hydrology, geology, fish and terrestrial ecology, and soil science. It is the framework for understanding and implementing land use activities within a geomorphic context and is a major component of the evolving science of ecosystem analysis. A critical step in this process is monitoring and feedback. If monitoring reveals that Riparian Management Objectives are not being met, the sequence of determining processes, defining Riparian Habitat Conservation Area boundaries and standards and guides will be repeated.

Watershed analysis consists of a sequence of activities designed to identify and interpret the processes operating in a specific landscape. The overall goals of watershed analysis are to:

1. Characterize the geomorphic, ecologic, and hydrologic context of a specific watershed with respect to neighboring watersheds, and identified beneficial uses.

2. Determine the type, aerial extent, frequency, and intensity of watershed processes, including mass movements, fire, peak and low streamflows, surface erosion, and other processes affecting the flow of water, sediment, organic material, or nutrients through a watershed.

3. Determine the distribution, abundance, life histories, habitat requirements, and limiting factors of fish and other riparian dependent species.

4. Identify parts of the landscape, including hillslopes and channels, that are either sensitive to specific disturbance processes or critical to beneficial uses, key fish stocks or species.

5. Interpret watershed history, including the effects of previous natural disturbances and land use activities on watershed processes.

6. Establish ecologically and geomorphically appropriate boundaries of Riparian Habitat Conservation Areas.

7. Design approaches to evaluate and monitor the reliability of the analysis procedure and the effectiveness of designated Riparian Habitat Conservation Areas to protect fish habitat.

8. Identify restoration objectives, strategies, and priorities.

The idea of watershed analysis is not new. Many National Forests have been conducting planning exercises that use elements of watershed analysis. However, few, if any, National Forests conduct a comprehensive watershed analysis. Furthermore, there is little consistency in objectives, methods, or results among Forests or ranger districts. Current efforts typically address only limited aspects of the problem (e.g., identifying unstable ground, or scheduling timber harvest to minimize the area in cutover or young stands at any given time). Little effort is made to identify effects of past practices or limiting factors for fish or other riparian dependent organisms. Watershed analysis falls between the scales of Forest and Project Planning; it is not a scale at which decisions are made. However, it is the critical scale for evaluating and making decisions about cumulative watershed effects.

In recent years, formal watershed analysis has begun to come to the forefront of forest land management and is now required by law on state and private forest lands in Washington (Washington State Forest Practice Board 1992). Within the Forest Service, an example watershed analysis is the Draft Environmental Impact Statement for the Elk River Wild and Scenic River Plan, Siskiyou National Forest, Forest Service (USDA 1992b). An across-the-board requirement for watershed analysis does not exist, however, within the Forest Service.

Implementing watershed analysis will require major changes in Forest Service planning and management activities. To help with this transition, and to allow for planning and forest management activities to proceed in the face of the large task of performing watershed analysis in all National Forest watersheds in the owl region, two levels of analysis will be employed (Fig. 6-K-6):

Level I Analysis

Objectives: Level I analysis is less rigorous. It will assess current watershed conditions, identify watersheds currently providing or likely to provide high quality habitat, evaluate the ecologic and geomorphic processes critical for maintaining fish habitat, determine which watersheds require Level II analysis, and establish Riparian Habitat Conservation Area boundaries for watersheds not requiring Level II analysis.

Scale: Level I analysis typically is conducted on watersheds from 10,000 to 100,000 acres (roughly 5th- to 6th-order).

Data used: Level I analysis typically relies on existing data, including topographic, geologic, soils, and vegetation maps; aerial photos; existing data on habitat and populations of fish and other riparian-dependent organisms; and existing mass movement inventories and streamflow records. Additional field work is required to set boundaries for watersheds not requiring Level II analysis.

Products: Level I analysis assesses current watershed, riparian, and stream conditions and factors limiting fish habitat. Sequential aerial photos are examined to determine the frequency, magnitude, and spatial distribution of key disturbance processes within the watershed that influence fish habitat (e.g., landslides, debris flows, windthrow, fire). Stream flow records and channel inventories are used to determine if there is evidence for peak or low flow changes due to land management activities. Surveys of distribution and abundance or fish and other riparian-dependent species are used to determine if at-risk organisms are present. Past, ongoing, and foreseeable future projects are evaluated to determine their effects on disturbance regime and riparian habitat~ and to determine if the Riparian Management Objectives are being met.

This information is used to determine whether past, present, or future management activities pose low, moderate, or high risk to riparian and stream habitat. For example, a watershed is classified as high or moderate risk if it has a history of slope instability, streamflow problems, threatened or endangered species or fish stocks, or management activities, either individually or collectively, that are likely to significantly change the disturbance regime contributing to fish habitat. Such a watershed requires a Level II analysis. For

those watersheds where management activities pose a low risk to fish habitat, boundaries of Riparian Habitat Conservation Areas are delineated based on Level I analysis. These boundaries are established in the field using interim widths described in the previous section on Riparian Habitat Conservation Areas (Component 2) for different water bodies.

Time and personnel: Based on the time required to complete comparable efforts conducted by the Forest Service, Level I analysis should require approximately 5-7 weeks of a 4-person interdisciplinary team composed of a fish biologist, wildlife biologist, hydrologist, and geologist for a 50,000~acre watershed. This estimate assumes that topographic, geologic, soils, and vegetation map data and time-series aerial photographs are available.

Level II Analysis

Objectives: Level II analysis is more rigorous. It will establish ecologically appropriate boundaries of Riparian Habitat Conservation Areas, and identify restoration needs and priorities.

Scale: Level II analysis is carried out on watersheds of approximately 10,000 to 50,000 acres.

Data used: Level II analysis represents a refinement and extension of Level I analysis. Field maps of unstable areas, a road condition survey, inventory of riparian canopy conditions, intensive survey of channel conditions, and computer simulations of hillslope and channel processes would be used. Level II analysis typically involves additional field work to provide watershed-specific information on ecologic and geomorphic conditions.

Products: Level II analysis establishes operational boundaries of Riparian Habitat Conservation Areas to meet the Riparian Management Objectives, produces a transportation plan for the watershed, refine standards and guidelines to fit specific landscape conditions and limitations, establishes restoration goals, sets restoration priorities, and establishes a monitoring program to insure that Riparian Management Objectives are met.

Time and personnel: Level II analysis should require an additional 5-7 weeks of a 4-person interdisciplinary team for a 50,000-acre watershed. Total time to complete both Level I and II analysis of a 50,000-acre watershed should be approximately 40-56 person-weeks.

Because of their importance in providing high quality fish habitat and/or their high proportion of unstable landforms, all key watersheds (previously described) and inventoried roadless areas would require a Level II analysis.

Component 4 - Watershed Restoration - Watershed restoration addresses improving the current conditions of watersheds to restore degraded habitat and provide long-term protection to aquatic resources. To be effective in restoring salmonid habitats, a restoration strategy needs to incorporate:

— A regional strategy that looks across landscapes and ownerships to identify where restoration efforts are likely to be most effective;

— An explicit recognition of how differences in physiography and specific impacts on stream systems will require different restoration measures;

— A detailed watershed analysis (Component 3) to adapt restoration strategies to specific landscapes, taking into account unique watershed histories, conditions, and resources;

— A specific set of objectives for each watershed;

— An explicit role for research and monitoring in defining and refining restoration objectives and tracking the effectiveness of restoration measures.

Elements of a restoration program are:

A. Identification of Priority Watersheds - Priority watersheds for restoration should be those with high restoration potential. Prioritization is necessary because of the large number of watersheds in National Forests within the range of the northern spotted owl that are in poor condition. Additionally, funds for programs are currently lacking and probably never will be sufficient to deal with all watersheds. However, some watersheds have been altered so excessively that they have little potential of recovery. Candidate watersheds that have the best chance of benefiting from a restoration program have already been identified as part of the key watershed network of Johnson et al. (1991).

B. Distinguish Physiographic Regions - Physiographic regions vary considerably in both their intrinsic sensitivities to watershed disturbance and in the specific impacts involved. Restoration strategies need to be tailored to the specific processes and conditions occurring in different regions. Watershed analysis is the key to developing landscape-specific strategies.

C. Watershed Analysis - Before any restoration activities begin, the watershed analysis described in Component 3 is needed. It will identify: watershed disturbance processes and where they occur on the landscape; current conditions of hillslopes and channels; status of aquaticcommunities including threatened and endangered populations; limiting factors for riparian ecosystems; inventory of past land use practices, including roads, clearcuts, grazing allotments, and mining impacts.

D. Define Restoration Objectives and Strategies - The watershed analysis will provide a spatially explicit set of objectives for restoration activities. These objectives establish the framework for restoration work, including what measures are needed, where they are to be carried out, which techniques need to be used, what sequence of actionshould be planned, and how the work is to be accomplished.

E. Research and Monitoring Included in Restoration Plans - There is limited experience and few successes in restoring watersheds and ecosystems. To learn from our actions, a researcl, perspective needs to be utilized and monitoring built directly into the restoration strategy. Restoration needs to be based on scientifically credible concepts of how watersheds and their biota function. A research perspective considers replication, stratification, statistical design, sampling protocols, and responsibility for data management and analysis.

SUMMARY

This conservation strategy for habitat of at-risk stocks of anadromous salmonids and resident fish in the National Forests within the range of the northern spotted owl represents significant change from current management. It is a long-range program that maintains the existing balance of processes, functions, and habitat elements in intact aquatic and riparian ecosystems, and initiates the recovery of processes and functions in degraded systems. We believe that if this strategy is carried out in conjunction with other protection measures outlined in this plan, it will lead to a functioning landscape that buffers and absorbs disturbances to streams rather than amplifies them. In the long-term, we believe that if this conservation strategy is implemented, all streams in National Forests within the range of the northern spotted owl will eventually contain good fish habitat.

We reiterate that this fish habitat conservation strategy will not, by itself, prevent further declines or extirpation of at-risk stocks of anadromous salmonids. Reduction of the quantity and quality of freshwater habitat and disruption of ecological processes and functions are only one of the factors responsible for the decline of anadromous fish stocks. We believe that this strategy in combination with the other components proposed by the Scientific Analysis Team will accommodate the naturally dynamic nature of stream and riparian systems in the owl forests, help the recovery of degraded systems to more productive states, maintain options for future management, and sustain fish habitat and ecologically necessary riparian and watershed functions until additional knowledge allows us to implement new management measures.

Appendix 5-K
Strategy for Managing Habitat of At-Risk Fish Species

Tables

Table 5-K-1 At-Risk Species of Anadromous SaJmonids and Resident Fish Found on Nation~l Forests Within the Range of the Northern Spotted Owl.

A. Anadromous Salmonids	
coho salmon	Oncorhynchus kisutch
chinook salmon	O. tshawytscha
sockeye salmon	O. nerka
chum salmon	O. keta
pink salmon	O. gorbuscha
steelhead trout	O. mykiss
sea-run cutthroatrout	O. clarkii clarkii
B. Resident Fish	
redband trout	O. mykiss gibbsi
bull trout	Salvelinus confluentus
Oregon chub	Oregonichthys crameria
Olympic mudminnow	Novumbra hubbsi

Appendix 5-K
Strategy for Managing Habitat of At-Risk Fish Species

Tables (continued)

Old-Growth Species
Table 5-K-2 Changes in the Frequency of Large, Deep Pools (>50 yds2 and >6 Feet Deep) Between 1935 and 1992 in Streams on National Forests Within the Range of the Northern Spotted Owl.

		1935-1945		1987-1992		
	Miles Surveyed	Number	Number/ Miles	Number	Number/ Pool	Percent Change
Western Washington						
Cascades						
Cowlitz River Basin	52.1	421	8.1	176	3.4	-58%
Lewis River Basin	4.8	22	4.6	13	2.7	-41%
Wind River Basin	35.4	75	2.1	80	2.3	10%
Coastal						
Grays River Basin	20.7	107	5.2	34	1.6	-69%
Elochoman River Basin	21.5	79	3.7	13	0.6	-84%
Abernathy Basin	8.3	3	0.4	3	0.4	-NC
Germany Basin	8.0	7	0.9	4	0.5	-44%
Coweeman River Basin	26.4	87	3.3	4	0.2	-94%
Eastern Washing ion						
Yakima River Basin	28.5	98	3.4	14	0.5	-85%
Wenatchee River Basin	60.7	143	2.4	125	2.1	-13%
Methow River Basin	119.0	106	0.9	52	0.4	-56%
Coastal Oregon						
Lewis and Clark River	10.4	47	4.5	10	1.6	-78%
Clatskanie River	15.5	135	8.7	20	1.3	-85%

Appendix 5-K
Strategy for Managing Habitat of At-Risk Fish Species

Tables (continued)

Table 5-K-3 Spawning and Stream Rearing Habitat Factors That Potentially Limit natural Production of Coastal Oregon Anadromous Salmonids. Factors were assessed as: H = has high potential to limit natural production and M = has medium potential to limit natural production. A "?" indicates that insufficient information exists for making a professional judgement; A "*" indicates a priority for gathering new information to help in restoration of fish populations (from: Panel on Factors Potentially Limiting Natural Production, Oregon Governor's Coastal Salmonid Restoration Initiative, Oregon Department of Fish and Wildlife, Portland, Oregon).

FACTOR 1: SPAWNING HABITAT

	Holding Pools	Migration Barriers	Gravel Quantity/Quality	Water Quantity/Quality	Temperature
Coho	-	-	M	-	-
Chum	-	M	H	M	-
Pall Chinook	M	-	H	?	-
Spring Chinook	M	-	H	?	M
Summer Steelhead	-	-	-	?	-
Winter Steelhead	-	-	-	-	-
Sea-run Cutthroat	?	M	?	-	-

FACTOR 2: STREAM REARING HABITAT

	Channel Complexity	Streamflow	Temperature	Migration Barriers	Flood Plain and Wetland	Other
Coho	H	M	H	?*	H	
Chum [1]	-	-	-	?*	-	
Fall Chinook	M*	M*	M*	?*	?*	
Spring Chinook	H*	M*	M*	?*	?*	
Summer Steelhead	H	H	H	?*	H	
Winter Steelhead	H	H	H	?*	H	
Sea-run Cutthroat	H	H*	H*	?*	H	

[1]Potential limitation of chum salmon production during the free-swimming freshwater phase of life cycle is believed to be minor because churn fry move quickly downstream to the estuary soon after emergence and do not reside in streams.

Old-Growth Species

Anadromous Stocks

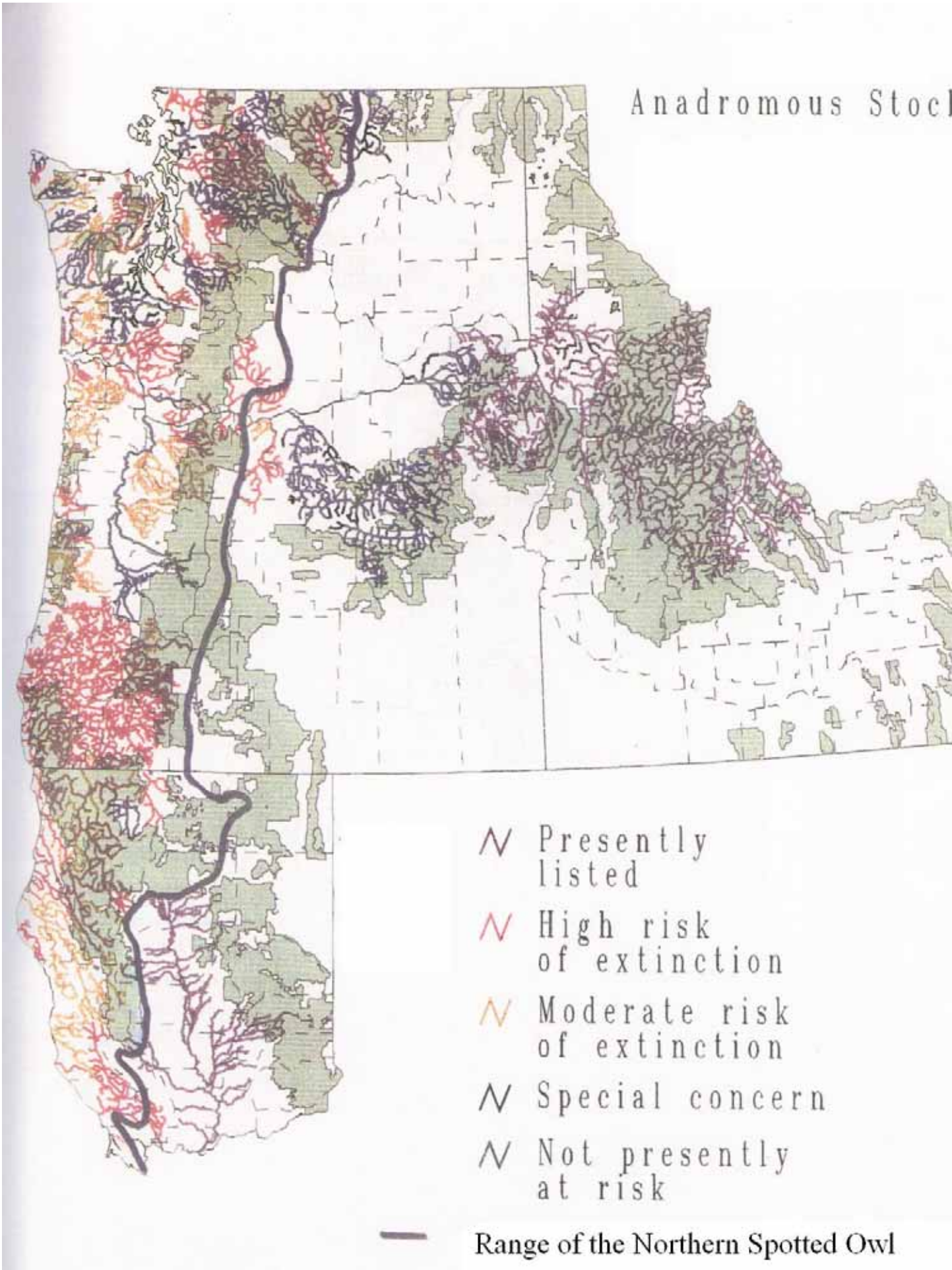
Figure 5-K-1 Range and Status of At-Risk Anadromous Salmonid Stocks and Resident Fish Species in Washington, Oregon, Northern California, and Idaho (see facing page).

This map was produced from a 1:500,000 scale stream network developed by the Environmental Protection Agency. Due to the small scale of the map, streams smaller than 5th order are not displayed. The result is that some small coastal and headwater tributaries are not depicted. The map represents available data for all land ownerships, both public and private. In basins with more than one stock at risk, the highest risk code was assigned to the entire drainage.

Risk codes are those of Nehlsen et al. (1991) and are defined as follows:

> **Presently Listed**: stocks currently listed under the Endangered Species Act.
>
> **High Risk of Extinction**: not self-sustaining (spawner:returning spawneratio <1); continue to decline despite conservation efforts.
>
> **Moderate Risk of Extinction**: presently self-sustaining (spawner:returning spawner ratio = 1 or slightly more) after previously declining more than natural variation would account for.
>
> **Special Concern**: 1) relatively minor disturbances could make population not self-sustaining; 2) insufficient information on population trend, but available data suggests depletion; 3) relatively large ongoing release of non-native fish, the potential for inbreeding with the native population exists; 4) population is not presently depleted but requires attention because of a unique character.

Data for this map were derived from Nehlsen et al. 1991, and Johnson et al. 1991.


Anadromous Stock
Presently listed
High risk of extinction
Moderate risk of extinction
Special concern
Not presently at risk
Range of the Northern Spotted Owl

California Key Watersheds

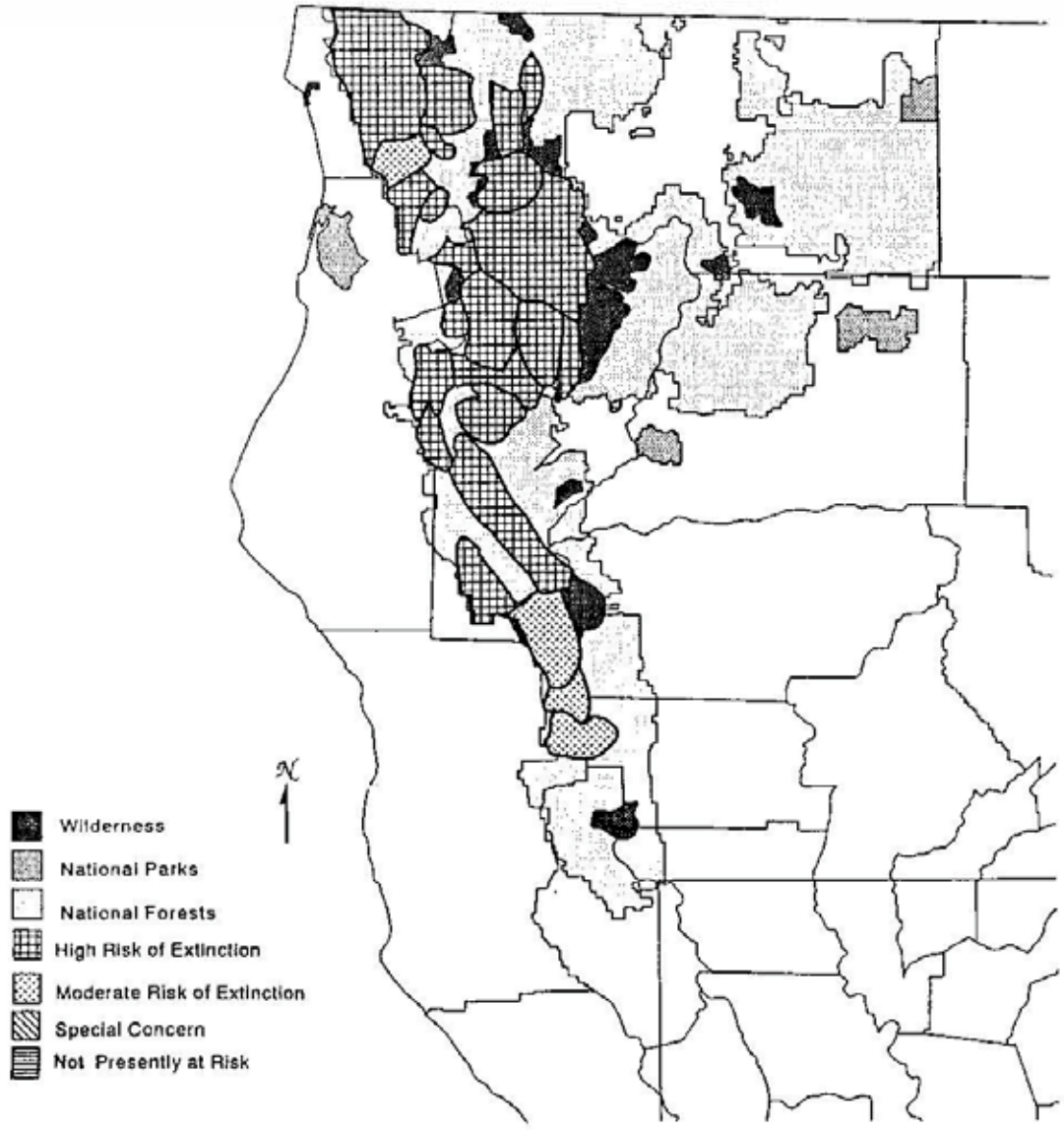


Figure 5-K-2 Location of Key Watersheds Which Could Serve as Aquatic Biodiversity Management Areas in California and Status of Anadromous Salmonid Stocks (as determined by Nehlsen et al. 1991) and Other Fish Species (as determined by Williams et al. 1989) Within Streams.

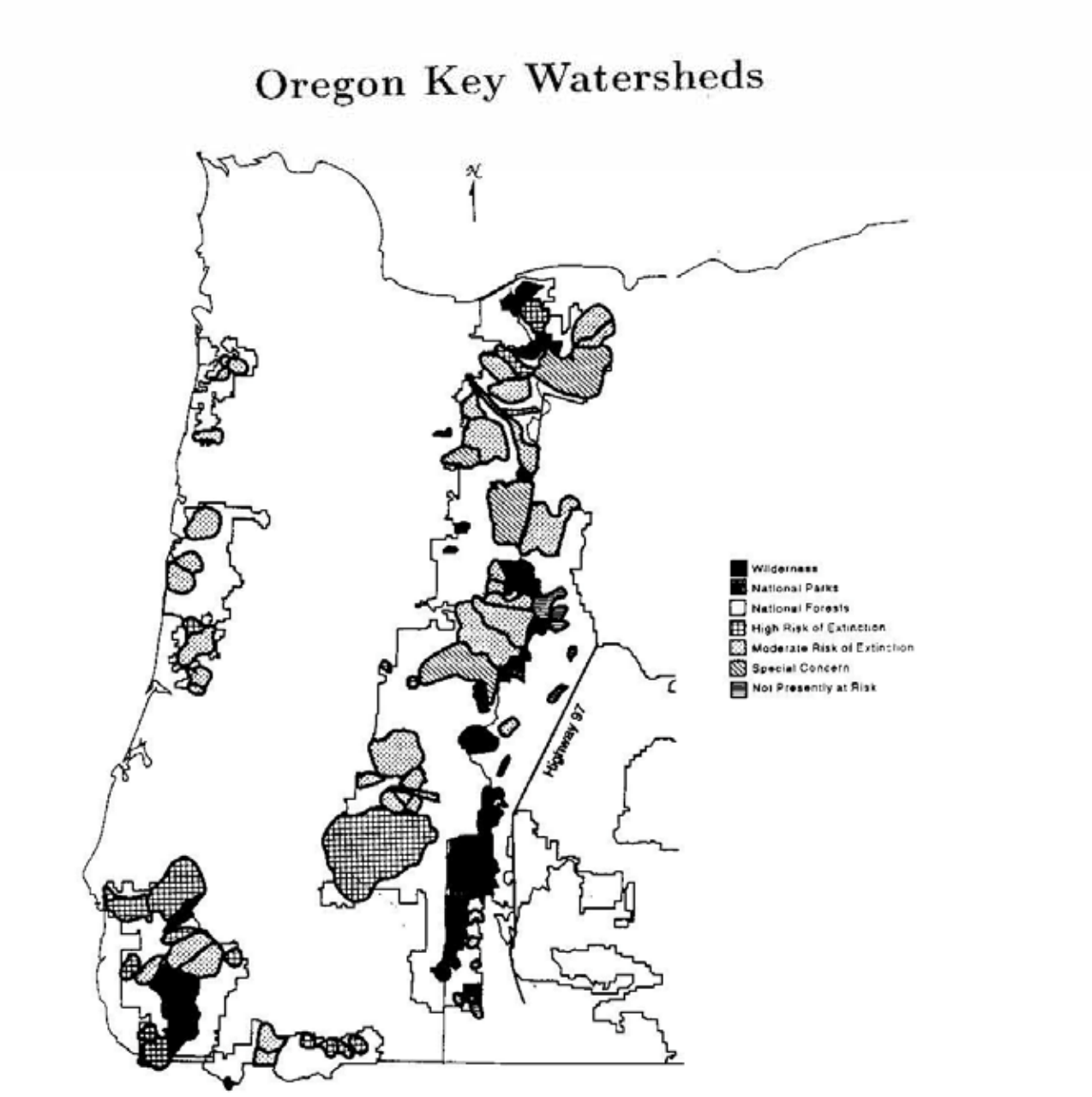


Figure 5-K-3 Location of Key Watersheds Which Could Serve as Aquatic Biodiversity Management Areas in Oregon and Status of Anadromous Salmonid Stocks (as determined by Nehlsen et al. 1991) and Other Fish Species (as determined by Williams et al. 1989) Within Streams.

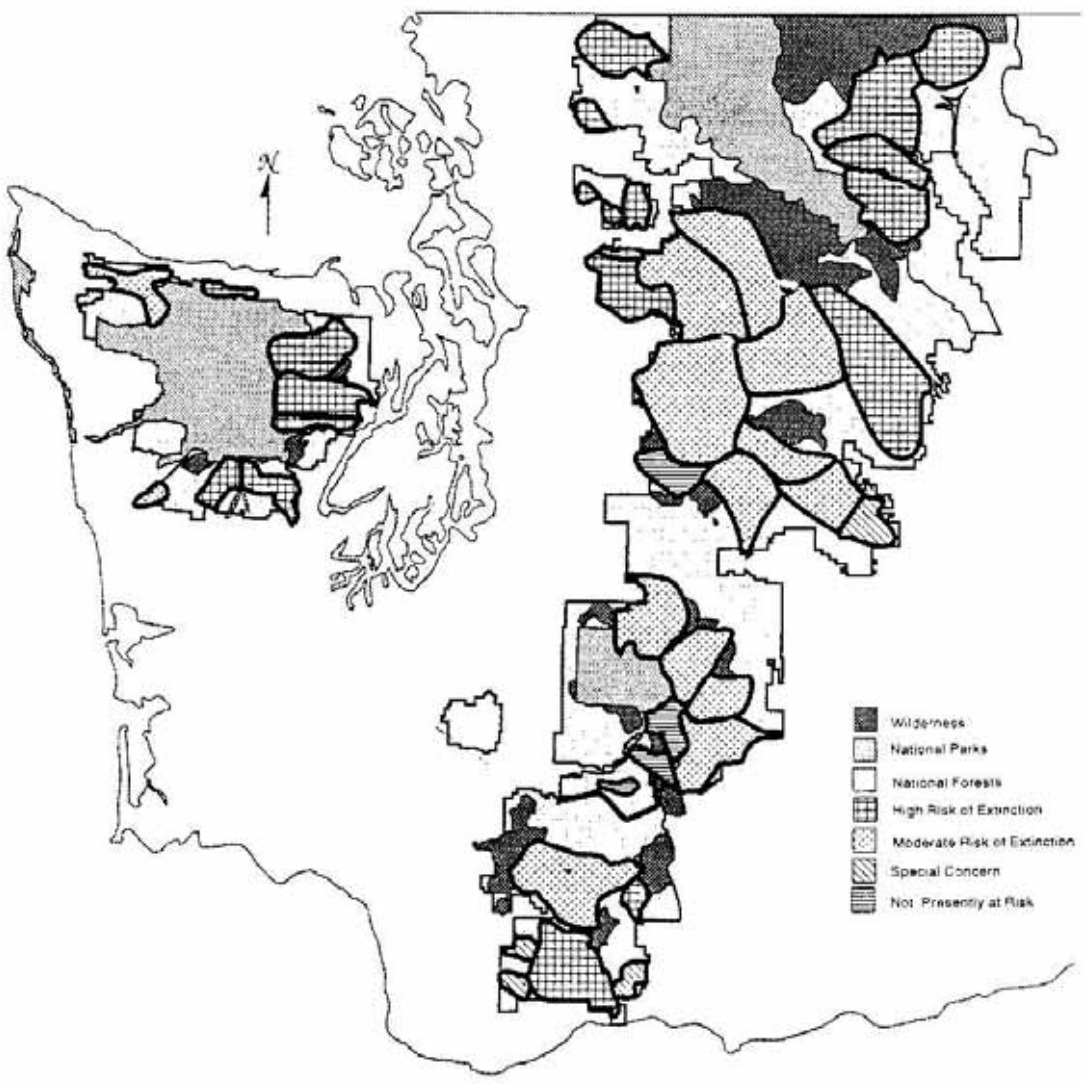


Figure 5-K-4 Location of Key Watersheds Which Could Serve as Aquatic Biodiversity Management Areas in Washington and Status of Anadromous Salmonid Stocks (as determined by Nehlsen et al. 1991) and Other Fish Species (as determined by Williams et al. 1989) Within Streams.

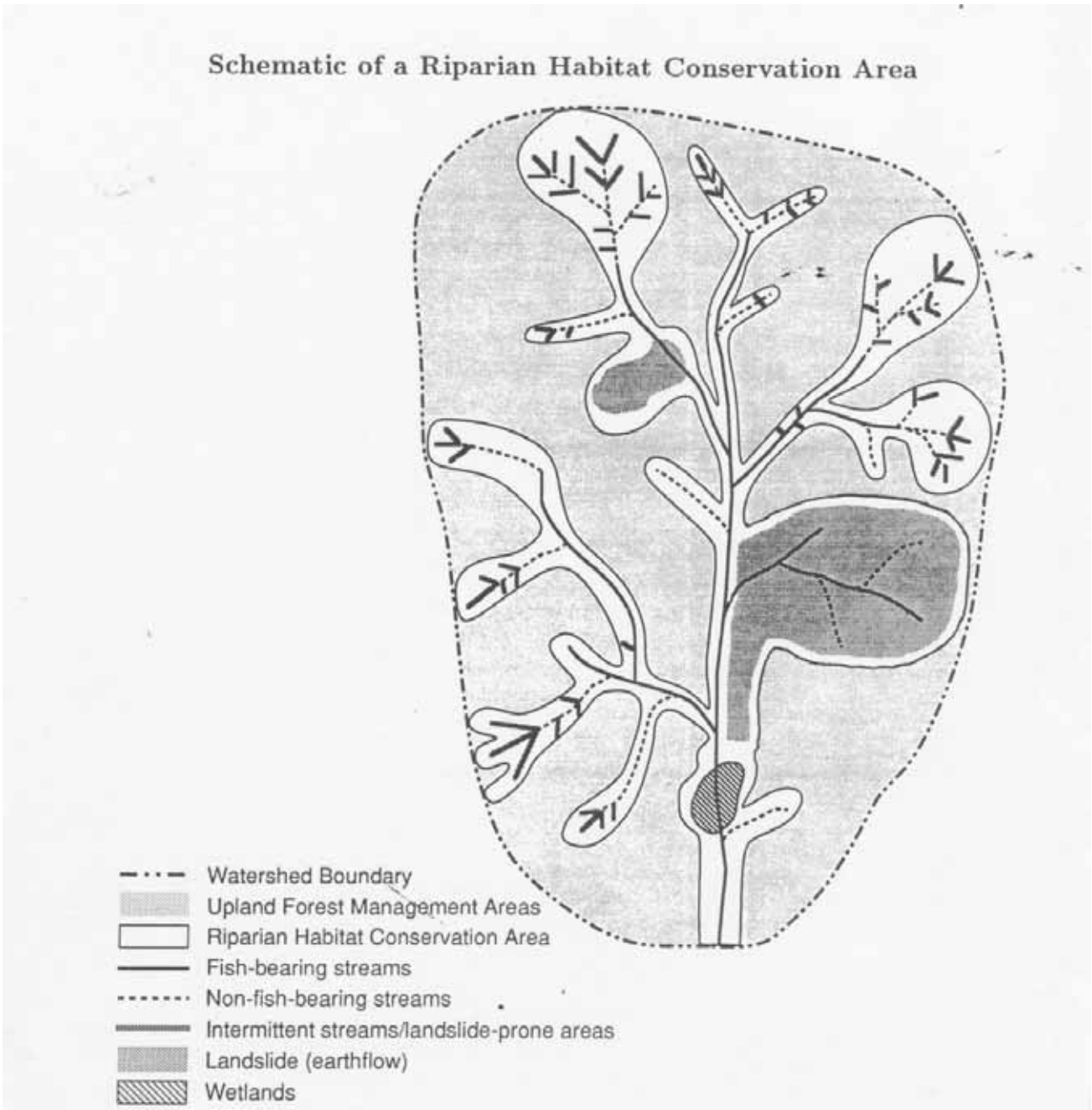


Figure 5-K-5 Schematic of a Riparian Habitat Conservation Area. Included within the Riparian Habitat Conservation Area are all seasonally flowing or intermittent streams, wetlands, landslides, and landslide-prone areas.

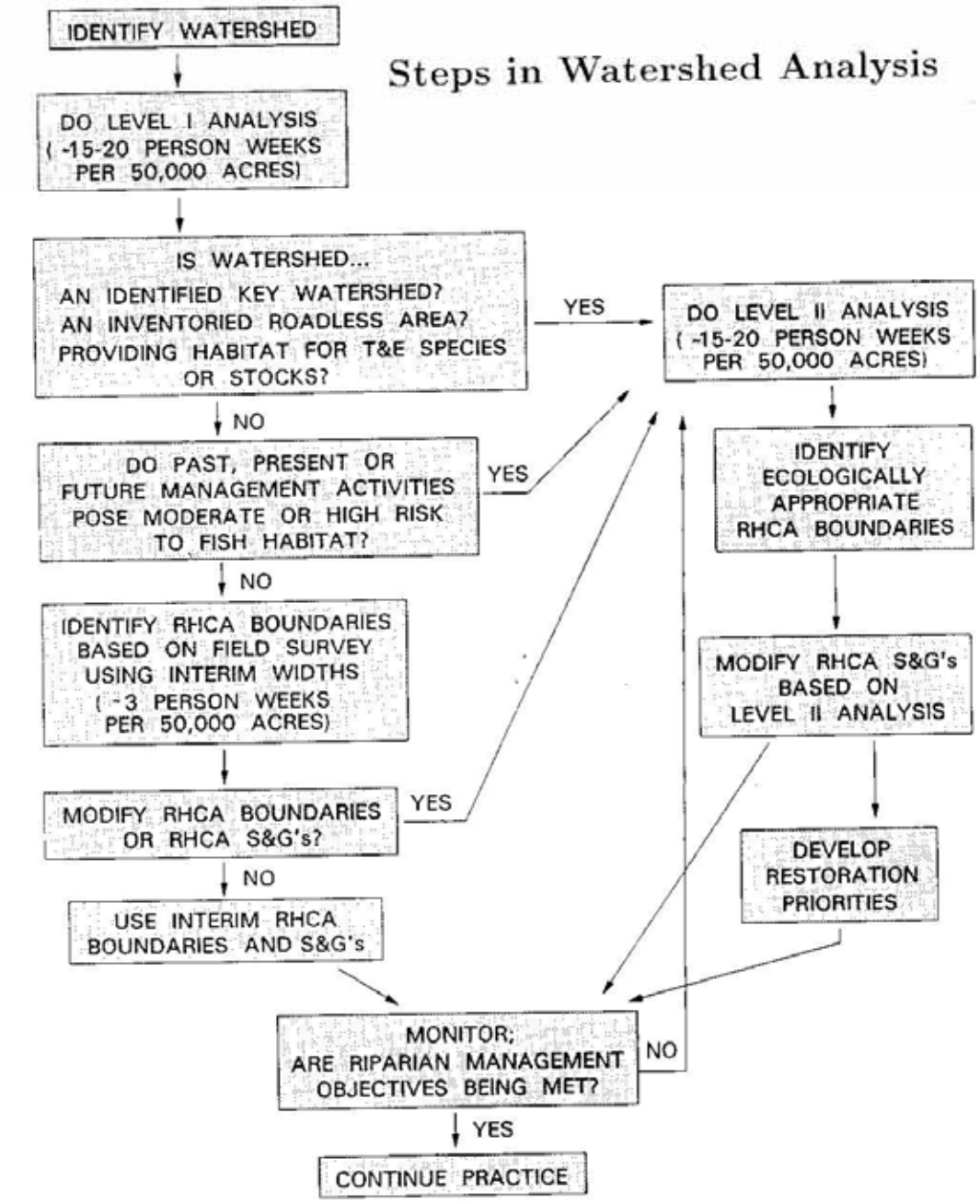


Figure 5-K-6 Flow Diagram of Proposed Watershed Analysis Procedure.

References

Allendorf, F.W. 1988. Conservation biology of fishes. Conservation Biology. 2: 145-148.

Andrus, C.W.; Long, B.A.; Froehlich, H.A. 1988. Woody debris and its contribution to pool formation in a coastal stream 50 years after logging. Canadian Journal of Fisheries and Aquatic Sciences. 45: 2080-2086.

Angermeier, P.L.; Karl J.R. 1984. Relationship between woody debris and fish habitat in a small warmwater stream. Proceedings of the American Fisheries Society. 133: 716-726.

Baltz, D.M.; Moyle, P.B.; Knight, N.J. 1982. Competitive interactions between benthic stream fishes, riffle sculpin (*Cottus gulosus*), and speckled dace (*Rhinichthys osculus*). Canadian Journal of Fisheries and Aquatic Sciences. 39: 1502-1511.

Benda, L.; Beechie, T.J.; Wissmar, R.C.; Johnson, A. 1992. Morphology and evolution of salmonid habitats in a recently deglaciated river basin, Washington State, USA. Canadian Journal of Fisheries and Aquatic Sciences.
49: 1246-1256.

Benda, L.; Zhang, W. 1990. The hydrological and geomorphological characteristics of landslide/dam-break floods in the Cascade Range of Washington. EOS. Proceedings of the American Geophysical Union.

Benner, P.A. 1992. Historical reconstruction of the Coquille River and surrounding landscape. Sections 3.2, 3.3 in: The action plan for Oregon coastal watersheds, estuaries, and ocean waters. Near Coastal Waters National Pilot Project, EPA, 1988-1991. Portland, OR: Conducted by the Oregon Department of Environmental Quality.

Berkman, II.E.; Rabini, C.F. 1987. Effect of siltation on stream fish communities. Environmental Biology of Fishes. 18: 285-294.

Berman, C.; Quinn, T.P. 1991. Behavioral thermoregulation and homing by spring chinook salmon, (*Oncorhynchus tshawytscha* Walbaum), in the Yakima River. journal of Fish Biology. 39: 301-312.

Beschta, R.L. 1978. Long-term patterns of sediment production following road construction and logging in the Oregon Coast Range. Water Resources Research. 14: 1011-1016.

Beschta, R.L.; Bilby, R.E.; Brown, G.W, [and others]. 1987. Stream temperature and aquatic habitat: fisheries and forestry interactions. Pages 191-232 in: Salo, E.O.; Cundy, T.W., eds. Forestry and fisheries interactions. Contribution 57. Seattle, WA: University of Washington, Institute of Forest Resources.

Bilby, R.E.; Ward, J.W. 1991. Large woody debris characteristics in streams draining old-growth, dear-cut, and second-growth forest in southwestern Washington. Canadian Journal of Fisheries and Aquatic Sciences. 48: 2,499-2,508.

Bilton, H.T.; Alderice, D.F.; Schnute, J.T. 1982. Influence of time and size at release of juvenile coho salmon (Oncorhynchus kisutch) on returns at maturity. Canadian Journal of Fisheries and Aquatic Sciences. 39: 426-447.

Bisson, P.A.; Bilby, R.E.; Bryant, M.D., [and others]. 1987. Large woody debris in forested streams in the Pacific Northwest: past, present, and future. Pages 143-190 in: Salo, E.O.; Cundy, T.W., eds. Streamside management: forestry and fishery interactions. Contribution No. 57. Seattle, WA: University of Washington, Institute of Forest Resources.

Bisson, P.A.; Quinn, T.P.; Reeves, G.H.; Gregory, S.V. 1992. Best management practices, cumulative effects, and long-term trends in fish abundance in Pacific Northwest river systems. Pages 189-232 in: Naiman, R.J., ed. Watershed management: balancing sustainability and environmental change. New York, NY: Springer-Verlag.

Bisson, P.A.; Sedell, J.R. 1984. Salmonid populations in streams in clearcut vs. old-growth forest of western Washington. Pages 121-129 in: Meehan, W.R.; Merrell, T.R., Jr.; Hanley, T.A., eds. Fish and wildlife relationships in old-growth forests: Proceedings of a symposium. Asheville, NC: American Institute of Fishery Research Biologists.

Bjornn, T.C.; Reiser, D.W. 1991. Habitat requirements of salmonids in streams. American Fisheries Society Special Publication 19. 83-138 p.

Bottom, D.L.; Nickelson, T.E.; Johnson, S.L. 1986. Research and development of Oregon's coastal salmon stocks: coho salmon model. Portland, OR: Oregon Department of Fish and Wildlife; annum progress report. 29 p.

Bryant, F.G. 1949. A survey of the Columbia River and its tributaries with special reference to its fishery resources. No. 2, Area I, Washington streams from the mouth of the Columbia River to and including the Klickitat River. Special Scienticfic Report No. 62. U.S. Department of the Interior, Fish and Wildlife Service. 110 p.

Bryant, F.G.; Parkhurst, Z.E. 1950. Survey of the Columbia River and its tributaries. No. 4, Area III, Washington streams from the Klickitat and Snake Rivers to Grande Coulee Dam, with notes on the Columbia and its tributaries above Grande Coulee Dam. Special Scientific Report on Fisheries No. 37. U.S. Department of the Interior, Fish and Wildlife Service. 108 p.

Bryant, M.D. 1980. Evolution of large, organic debris after timber harvest: Maybeso Creek, 1949 to 1978. Gen. Tech. Rep. PNW-101. U.S. Department of Agriculture, Forest Service.

Bury, R.B.; Corn, P.S.; Aubry, K.B., [and others]. 1991. Aquatic amphibian communities in Oregon and Washington. Pages 353-362 in: Ruggiero, L.F.; Aubry, K.B.; Carey, A.B.; Huff, M.tI., tech. coords. Wildlife and vegetation of unmanaged Douglas-fir forests. Gen. Tech. Rep. PNW-GTR-285. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Caruso, J.R. 1973. Regeneration within a middle-elevation Douglas-fir dearcut. Seattle, WA: University of Washington. Ph.D. dissertation.

Cederholm, C.J.; Reid, L.M. 1987. Impact of forest management on coho salmon (**Oncorhynchus kisutch**) populations of the Clearwater lever, Washington: a project summary. Pages 373-398 in: Salo, E.O.; Cundy, T.W., eds. Streamside management: forestry and fishery interactions. Contribution 57. Seattle, WA: University of Washington, Institute of Forest Resources.

Chapman, D.W. 1988. Critical review of variables used to defineffects of fines in redds of large salmonids. Proceedings of the American Fisheries Society. 117: 1-21.

Chen, J. 1991. Edge effects: microclimatic pattern and biological responses in old-growth Douglas-fir forests. Seattle, WA: University of Washington. 174 p. Ph.D. dissertation.

Chen, J.; Franklin, J.F.; Spies, T.A. [In press]. Microclimatic gradients from the clearcut edge into the old-growth Douglas-fir forest. Landscape Ecology.

Coats, R. 1987. Cumulative watershed effects: a historical perspective. Pages 107-111 in: Callaham, R.Z.; DeVries, J.J., tech. coords. California watershed management: Proceedings of a symposium; 1986 November 18-20; Sacramento, CA. Wildlands Resources Center Report No. 11. Berkeley, CA: University of California.

Coats, R.; Collins, L.; Forsheim, J.; Kaufman, D: 1985. Channel change, sediment transport, and fish habitat in a coastal stream: effects of an extremeven. Environmental Management. 9: 35-48.

Cordane, A.J.; Kelley, D.W. 1961. The influences of inorganic sediment on the aquatic life of streams. California Fish and Game. 47: 189-228.

Crowder, L.B.; Cooper, W.E. 1982. Habitat structural complexity and the interaction between bluegill and their prey. Ecology. 63: 1802-1813.

Doyle, A.T. 1986. Small mammal micro- and macrohabitat selection in streamside ecosystems. Corvallis, OR: Oregon State University, Department of Zoology. Ph.D. dissertation.

Doyle, A.T. 1990. Use of riparian and upland habitats by small mammals. Journal of Mammology. 71: 14-23.

Everest, F.tt.; Beschta, R.L.; Scrivener, J.C., [and others]. 1987. Fine sediment and salmonid production: a paradox. Pages 98-142 in: Salo, E.O.; Cundy, T.W., eds. Streamside management: forestry and fishery interactions. Contribution 57. Seattle, WA: University of Washington, Institute of Forest Resources.

Franklin, J.F.; Cromack, K., Jr.; Denison, W., [and others]. 1981. Ecological characteristics of old-growth Dougl~-fir forests. Gen. Tech. Rep. PNW-118. Portland, OR: U.S. Department of the Interior, Forest Service, Pacific Northwest Forest and Range Experimental Station. 48 p.

Frissel, C.A. 1992. Cumulative impacts of land use on salmon habitat in south coastal Oregon. Corvallis, OR: Oregon State University. 227 p. Ph.D. dissertation.

Fritschen, L.J.; Driver, C.; Avery, C., [and others]. 1970. Dispersion of air tracers into and within a forested area: #3. ECOM-68-GS-3, USAECOM. Fort Huachuca, AZ: Atmospheric Science Laboratory.

Furniss, M.J.; Roelofs, T.D.; Yee, C.S. 1991. Road construction and maintenance. American Fisheries Society Special Publication 19. 297-324 p.

Geiger, R. 1965. The climate near the ground. Cambridge, MA: Harvard University Press.

Gomez, D.M. 1992. Small mammal and herpetofauna abundance in riparian and upslope areas of five forest conditions. Corvallis, OR: Oregon State University. 118 p.M.S, thesis.

Gorman, O.T.; Karr, J.W. 1978. Habitat structure and stream fish communities. Ecology. 59: 507-515.

Grant, G.E. 1986. Downstream effects of timber harvest activities on the channel and valley floor morhpology of western Cascade streams. Baltimore, MD: Johns Hopkins University. Ph.D. dissertation.

Grant, G.E.; Wolff, A.L. 1991. Long-term patterns of sediment transport after timber havest, western Cascade Mountains, Oregon, USA. Pages 31-40 in: Sediment and stream water quality in a changing environment: trends and explanation: Proceedings of a symposium; 1991 August 11-24; Vienna. Austria. IAHS Publication 203.

Gregory, S.V.; Ashkenas, L. 1990. Riparian management guide, Willamette National Forest. Portland, OR: U.S Department of Agriculture, Forest Service, Pacific Northwest Region. 120 p.

Gregory, S.V.; Lambertti, G.A.; Erman, D.C., [and others]. 1987. Influence of forest practices on aquatic production. Pages 233-256 in: Salo, E.O.; Cundy, T.W., eds. Streamside management: forestry and fishery interactions. Contribution 57. Seattle, WA: Univeristy of Washington, Institute of Forest Resources.

Gregory, S.V.; Swanson, F.J.; McKee, W.A.; Cummins, K.W. 1991. An ecosystem perspective of riparian zones. BioScience. 41: 540-551.

Groot, C.; Margolis, L., eds. 1991. Pacific salmon life histories. Vancouver, BC: UBC Press. 564 p.

Gurtz, M.E.; Wallace, J.B. 1984. Substrate-mediated response of invertebrates to disturbance. Ecology. 65: 1556-1569.

Hager, R.C.; Noble, R.E. 1976. Relation of size at release of hatchery reared coho salmon to age, size and sex composition of returning adults. Progressive Fish Culturist. 38: 144-147.

Harmon, M.E.; Franklin, J.F.; Swanson, F.J., [and others]. 1986. Ecology of course woody debris in temperate ecosystems. Advances in Ecological Research. New York, NY: Academic Press; 15: 133-302.

Hartman, G.H. 1965. The role of behavior in the ecology and interaction of underyearling coho salmon (*Oncorhynchus kisutch*) and steelhead salmon (*Salmo gairdneri*). Journal of the Fisheries Research Board of Canada. 22: 1035-1061.

Heimann, D.C. 1988. Recruitment trends and physical characteristics of coarse woody debris in Oregon Coast Range streams. Corvallis, OR: Oregon State University. 121 p.M.S, thesis.

Henderson, M.A.; Cass, A.J. 1991. Effect of smolt size on smolt-to-adult survival of Chilko Lake sockeye salmon (*Onchorhynchus nerka*). Canadian journal of Fisheries and Aquatic Sciences. 41: 988-994.

Hicks, B.J. 1990. The influence of geology and timber harvest on channel geomorphology and salmonid populations in Oregon Coast Range streams. Corvallis, OR: Oregon State University. 199 p. Ph.D. dissertation.

Hicks, B.J.; Hall, J.D.; Bisson, P.A.; Sedell, J.R. 1991. Responses of salmonids to habitat change. American Fisheries Society Special Publication 19. 483-518 p.

Higgins, P.; Dobush, S.; Fuller, D. 1992. Factors in northern California threatening stocks with extinction. Humboldt Chapter, American Fisheries Society. 25 p. Unpublished report.

Holtby, L.B. 1988. Effects of logging on stream temperatures in Carnation Creek, British Columbia, and assoc"ated impacts on coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Sciences. 45: 502-515.

Holtby, L.B.; Scrivener, J.C. 1989. Observed and simulated effects of climatic variability, clear-cut logging and fishing on the numbers of chum salmon (*Oncorhynchus keta*) and coho salmon (*O. kisutch*) returning to Carnation Creek, British Columbia. Canadian Special Publication of Fisheries and Aquatic Sciences. 105: 62-81.

House, R.A.; Boehne, P.L. 1987. The effect of stream cleaning on salmonid habitat and populations in a coastal Oregon drainage. Western Journal of Applied Forestry. 2: 84-87.

Janda, R.J.; Nolan, K.M.; Harden, D.R.; Colman, S.M. 1975. Watershed conditions in the drainage basin of Redwood Creek, Humbolt County, California as of 1973. U.S. Geological Survey Open-File Report 75-568. 266 p.

Johnson, K.N.; Franklin, J.F.; Thomas, J.W.; Gordon, J. 1991. Alternatives for management of late-successional forests of the Pacific Northwest. A report to the Agriculture Committee and the Merchant Marine Committee of the U. S. House of Representatives. 59 p.

Kalleberg, H. 1958. Observations in a stream tank of territoriality and competition in juvenile salmon and trout (*Salmo saint L. and S. trutta L.*). Institute of Freshwater Research Drottingholm Report. 39: 55-98.

Karr, J.R. 1991. Biological integrity: a long-neglected aspect of water resource management. Ecological Applications. 1:66-84.

Karr, J.R.; Fausch, K.D.; Angermeier, P.L., [and others]. 1986. Assessing biological integrity in running waters: a method and its rationale. Special Publication 5. Champaign, IL: Illinois Natural History Survey.

Kaufmann, P.R. 1987. Channel morphology and hydraulic characteristics of torrent-impacted streams in the Oregon Coast Range, U.S.A. Corvallis, OR: Oregon State University. 235 p. Ph.D. dissertation.

Kelly, J.R.; Harwell, M.A. 1990. Indicators of ecosystem recovery. Environmental Management. 14: 527-546.

Kelsey, H.M.; Madej, M.A.; Pitlick, J., [and others]. 1981. Sediment sources and sediment transport in the Redwood Creek Basin: a progress report. Tech. Rep. 3. U.S. Department of the Interior, National Park Service, Redwood National Park Research and Development. 114 p.

Ketcheson, G.L.; Froehlich, H.A. 1978. Hydrology factors and environmental impacts of mass soil movements in the Oregon Coast Range. Report by the Water Resources Research Institute. Corvallis, OR: Oregon State Unviersity.

Leidy, R.A. 1984. Distribution and ecology of stream fishes in the San Francisco Bay Drainage. Itilgardia. 52: 152.

Li, H.W.; Schreck, C.B.; Bond, C.E.; Rexstad, E. 1987. Factors influencing changes in fish assemblages of Pacific Northwest streams. Pages 193-202 in: Matthews, W.J.; Heins, D.C., eds. Community and evolutionary ecology of North American stream fishes. Norman, OK: University of Oklahoma Press.

Lloyd, D.S.; Koenigs, J.P.; LaPerriere, J.D. 1987. Effects of turbidity in fresh waters of Alaska. North American Journal of Fisheries Management. 7: 18-33.

Long, B.A. 1987. Recruitment and abundance of large woody debris in an Oregon coastal stream system. Corvallis, OR: Oregon State University. 68 p.M.S, thesis.

Madej, M.A. 1984. Recent changes in channel-stored sediment Redwood Creek, California. Tech. Rep. 11. U.S. Department of the Interior, National Park Service, Redwood National Park Research and Development. 54 p.

Marion, D.A. 1981. Landslide occurrence in the Blue River drainage, Oregon. Corvallis, OR: Oregon State University. M.S. thesis.

Maser, C.; Tarrant, R.F.; Trappe, J.M.; Franklin, J.F. 1988. From the foresto the sea: a story of fallen trees. Gen. Tech. Rep. PNW-GTR-229. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

McDade, M.H.; Swanson, F.J.; McKee, W.A., [and others]. 1990. Source distances for coarse woody debris entering small streams in western Oregon and Washington. Canadian Journal of Forest Research. 20: 326-330.

McSwain, M.D. 1987. Summer stream temperature and channel characteristics of a southwest Oregon stream. Corvallis, OR: Oregon State University. 99 p. M.S. thesis.

Meehan, W.R., ed. 1991. Influences of forest and rangeland management on salmonid fishes and their habitat. American Fisheries Society Special Publication 19. 750 p.

Meehan, W.R.; Bjornn, T.C. 1991. Salmonid distributions and life histories. American Fisheries Society Special Publication 19. 47-82 p.

Megahan, W.F. 1982. Channel sediment storage behind obstructions in forestedrainage basins draining the granitic bedrock of the Idaho batholith. Pages 114-121 in: Swanson, F.J., [and others]. Sediment budgets and routing in forested drainage basins. Gen. Tech. Rep. PNW-141. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Megahan, W.F.; Kidd, W.J., Jr. 1972. Effects of logging and logging roads on erosion and sediment deposition from steep terrain. Journal of Forestry. 70: 136-141.

Megahan, W.F.; Potyondy, J.P.; Seyedbagheri, K.A. 1992. Best management practices and cumulative effects from sedimentation in the South Fork Salmon River: an Idaho case study. Pages 401-414 in: Naiman, R.J., ed. Watershed management: balancing sustainability and environmental change. New York, NY: Springer-Verlag.

Morman, D. 1993. Draft report: riparian rules effectiveness study report. Salem, OR: Oregon Department of Forestry.

Morrison, P.H. 1975. Ecological and geomorphological consequences of mass movements in the Alder Creek watershed and implications for forest land management. Eugene, OR: University of Oregon. B.S. thesis.

Moyle, P.B.; Sato, G.M. 1991. On the design of preserves to protect native fishes. Pages 155-169 in: Minckley, W.L.; Deacon, J.E., eds. Battle against extinction: native fish management in the American West. Tucson, AZ: University of Arizona Press.

Moyle, P.B.; Williams, J.E. 1990. Biodiversity loss in the temperate zone: decline of the native fish fauna of California. Conservation Biology. 4: 275-284.

Naiman, R.J.; Beechie, T.J.; Benda, L.E., [and others]. 1992. Fundamental elements of ecologically healthy watersheds in the Pacific Northwest coastal ecoregion. Pages 127-188 in:

Nalman, R.J., ed. Watershed management: balancing sustainabillty and environmental change. New York, NY: Springer-Verlag.

Narver, D.W. 1971. Effects of logging debris on fish production. Pages 100-111 in: Krygier, J.T.; Hall, J.D, eds. Forest land uses and stream environment: Proceedings of a symposium. Corvallis, OR: Oregon State University, Continuing Education Publications.

Nehlsen, W.; Williams, J.E.; Lichatowich, J.A. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries. 16(2): 4-21.

Nickelson, T.E. 1986. Influences of upwelling, ocean temperature, and smolt abundance on marine survival of coho salmon (*Oncorhynchus kisutch*) in the Oregon Production Area. Canadian Journal of Fisheries and Aquatic Sciences, 43: 527-535.

Niemi, G.J., [and others]. 1990. Overview of case studies on recovery of aquatic systems from disturbance. Environmental Management. 14: 5701-587.

Nolan, K.M.; Marron, D.C. 1985. Contrast in stream-channel response to major storms in two mountainous areas of California. Geology. 13: 135-138.

Nussbaum, R.A.; Brodie, E.D., Jr.; Storm, R.M. 1983. Amphibians and reptiles of the Pacific Northwest. Moscow, ID: University Press of Idaho. 332 p.

O'Loughlin, C.L. 1972. An investigation of the stability of the steepland forest soils in the Coast Mountains, southwest British Columbia. Vancouver, BC: University of British Columbia. 147 p. Ph.D. dissertation.

Parkhurst, Z.E. 1950a. Survey of the Columbia River and its tributaries, Part 6, Area V, Snake River from the mouth through the Grande Ronde River. Special Scientific Report 39. U.S. Department of the Interior, Fish and Wildlife Service. 58 p.

Parkhurst, Z.E. 1950b. Survey of the Columbia River and its tributaries, Part 7, Area VI, Snake River from above the Grande Ronde River through the Payette River. Special Scientific Report 40. U.S. Department of the Interior, Fish and Wildlife Service. 95 p.

Parkhurst, Z.E. 1950c. Survey of the Columbia River and its tributaries, Part 8, Area VIII, Snake River above Payette River to upper Salmon Falls. Special Scientific Report 57. U.S. Department of the Interior, Fish and Wildlife Service. 19 p.

Parkhurst, Z.E.; Bryant, F.G.; Nelson, R.S. 1950. Survey of the Columbia River and its tributaries, Part 3. Special Scientific Report 36. U.S. Department of the Interior, Fish and Wildlife Service. 103 p.

Pearcy, W.G. 1992. Ocean ecology of North Pacific salmonids. Seattle, WA: University of Washington Press. 179 p.

Quinn, T.P.; Tallman, R.F. 1987. Seasonal environmental predictability in riverine fishes. Environmental Biology of Fishes. 18: 155-159.

Ralph, S.C.; Puule, G.C.; Conquest, L.L.; Naiman, R.J. 1993. Stream channel condition and in-stream habitat in logged and unlogged basins of western Washinton. Unpublished manuscript. On file with: Center for streamside studies, AR-10, University of Washington, Seattle, WA.

Ranney, J.W. 1977. Forest island edges - their structure, development, and importance to regional forest ecosystem dynamics. Environmental Sciences Division Publication No. 1069. Oak Ridge, TN: Oak Ridge National Laboratory.

Raynor, G.S. 1971. Wind and temperature structure in a coniferous forest and a contiguous field. Forest Science. 17: 351-363.

Reeves, G.H.; Everest, F.H.; Hall, J.D. 1987. Interactions between the redside shiner (*Richardsonius balteatus*) and the steelhead trout (*Salmo gairdneri*) in western Oregon: the influence of water temperature. Canadian Journal of Fisheries and Aquatic Sciences. 44: 1603-1613.

Reeves, G.tI.; Everest, F.H.; Sedell, J.R. [In press]. Diversity of juvenile anadromous salmonid assemblages in basins in coastal Oregon, U.S.A. with different levels of timber harvest. Proceedings of the American Fisheries Society.

Reeves, G.H.; Sedell, J.R. 1992. An ecosystem approach to the conservation and management of freshwater habitat for anadromous salmonids in the Pacific Northwest. Proceedings of the 57th North American wildlife and natural resources conference. 408-415 p.

Reid, L.M.; Dunne, T. 1984. Sediment production from forest road surfaces. Water Resources Research. 20: 1753-1761.

Rich, W.H. 1948. A survey of the Columbia River and its tributaries with special reference to the management of its fishery resources. Special Scientific Report No. 51. U.S. Department of the Interior, Fish and Wildlife Service. 25 p.

Ricker, W. E. 1972. Hereditary and environmental factors affecting certain salmonid populations. Pages 19-160 in: Simon, R.C.; Larkin, P.A., eds. The stock concept in Pacific salmon. Vancouver, BC: University of British Columbia.

Rosgen, D.L. 1988. A stream classification system. Pages 163-179 in: Mutz, K.M. et al., eds. Restoration, creation and management of wetland and riparian ecosystems in the American West: Proceedings of a symposium; Rocky Mountain Chapter of Wetland Scientists; 1988 November 14-16; Denver CO. Denver, CO: PIC Technologies, Inc./CRSirrine, Inc.

Rutherford, D.A.; Echelle, A.A.; Maughan, O.E. 1987. Changes in the fauna of the Little River drainage, southeastern Oklahoma, 1948-1955 to 1981-1982: a test of the hypothesis of environmental degradation. Pages 178-183 in: Matthews, W.J.; tteins, D.C., eds. Community and evolutionary ecology of North American stream fishes. Norman, OK: University of Oklahoma Press.

Salo, E.O.; Cundy, T.W., eds. 1987. Streamside management: forestry and fishery interactions. Contribution No. 57. Seattle, WA: University of Washington, Institute of Forest Resources. 471 p.

Schlosser, I.J. 1982. Trophic structure, reproductive success, and growth rate of fish in a natural and modified headwater stream. Canadian Journal of Fisheries and Aquatic Sciences. 39: 968-978.

Schlosser, I.J. 1988. Predation risk and habitat selection by two size classes of a stream cyprinid: experimental test of a hypothesis. Oikos. 52: 36-40.

Schwartz, J.S. 1991. Influence of geomorphology and land use on distribution and abundance of salmonids in a coastal Oregon basin. Corvallis, OR: Oregon State University. 297 p.M.S thesis.

Scott, J.B.; Steward, C.R.; Stober, Q.J. 1986. Effects of urban development on fish population dynamics in Kelsey Creek, Washington. Proceedings of the American Fisheries Society. 115: 555-567.

Scrivener, J.C.; Brownlee, M.J. 1989. Effects of forest harvesting on spawning gravel and incubation survival of chum (*Oncovhynchus keta*) and coho salmon (*O. kisutch*) in Carnation Creek, British Columbia. Canadaian Journal of Fisheries and Aquatic Sciences. 46: 681-696.

Sedell, J.R.; Beschta, R.L. 1991. Bringing back the "bio" in bioengineering. Pages 160-175 in: Colt, J.; Dendall, S., eds. Fisheries bioengineering: Proceedings of a symposium; Bethesda, MD. American Fisheries Society Publication 10.

Sedell, J.R.; Everest, F.H. 1991. Historic changes in pool habitat for Columbia River Basin salmon under study for TES listing; draft report, December 1990. Corvallis, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 7 p.

Sedell, J.R.; Leone, F.N.; Duval, W.S. 1991. Water transportation of logs. American Fisheries Society Special Publication 19. 325-368 p.

Sedell, J.R.; Luchessa, K.J. 1982. Using the historical record as an aid to salmonid habitat enhancement. Pages 210-223 in: Armantrout, N.B., ed. Acquisition and utilization of aquatic inventory information: Proceedings of a symposium; Bethesda, MD. American Fisheries Society, Western Division.

Sedell, J.R.; Reeves, G.H.; Hauer, F.R., [and others]. 1990. Role of refugia in recovery from disturbance: modern fragmented and disconnected river systems. Environmental Management. 14: 711-724.

Sheldon, A.I. 1988. Conservation of stream fishes: patterns of diversity, rarity, and risk. Conservation Biology. 2: 149-156.

Stanford, J.A.; Ward, J.V. 1988. The hyporheic habitat of river ecosystems. Nature. 335: 64-66.

Statzner, B.; Gore, J.A.; Resh, V.H. 1988. Hydraulic stream ecology: observed patterns and potential applications. Journal of the North American Benthological Society. 7: 307-360.

Steinblums, I. 1977. Streamside bufferstrips: survival, effectiveness, and design. Corvallis, OR: Oregon State University. 181 p. M.S. thesis.

Strahler, A.N. 1957. Quantitative analysis of watershed geomorphology. Proceedings of the American Geophysical Union. Vol. 38. 913-920 p.

Sullivan, K.T.; Lisle, E.; Dollof, C.A., [and others]. 1987. Stream channels: the link between forests and fish. Pages 39-97 in: Saio, E.O.; Cundy, T.W., eds. Streamside management: forestry and fishery interactions. Contribution No. 57. Seattle, WA: University of Washington, institute of Forest Resources.

Swanson, F.J.; Dyrness, C.T. 1975. Impact of clear-cutting and road construction on soil erosion by landslides in the western Cascade Range, Oregon. Geology. 3: 393-396.

Swanson, F.J.; Gregory, S.V.; Sedell, J.R.; Campbell, A.G. 1982. Land-water interactions: the riparian zone. Pages 267-291 in: Edmonds, R.L., ed. Analysis of coniferous forest ecosystems in the western United States. Stroudsburg, PA: Hutchinson Ross.

Swanson, F.J.; Swanson, M.M.; Woods, C. 1981. Analysis of debris-avalanche erosion in steep forest lands: an example from Mapleton, Oregon, USA. Pages 67-75 in: Davies, T.R.H; Pearce, A.J., eds. Proceedings of the erosion and sediment transport in Pacific rim steeplands symposium; Washington, DC. International Association of Hydrological Sciences.

Swanston, D.N. 1991. Natural processes. American Fisheries Society Special Publication 19. 139-179 p.

Swanston, D.N.; Swanson, F.J. 1976. Timber harvesting, mass erosion, and steepland forest geomorphology in the Pacific Northwest. Pages 199-221 in: Coates, D.R., ed. Geomorphology and engineering. Stroudsburg, PA: Dowden, Hutchinson, and Ross, Inc.

Sweeney, B.W.; Vannote, R.L. 1978. Size variation and the distribution of hemimetabolous aquatic insects: two thermal equilibrium hypotheses. Science. 200: 444-446.

Ursitti, V.L. 1991. Riparian vegetation and abundance of woody debris in streams of southwestern Oregon. Corvallis, OR: Oregon State University. 115 p. M.S. thesis.

USDA Forest Service. 1992a. Background report for development of the Forest Service management strategy for Pacific salmon and steelhead habitat. Washington, DC. 41 p.

USDA Forest Service. 1992b. Siskiyou National Forest draft EIS: Elk River wild and scenic management plan. Grants Pass, OR.

USDI. 1992. Recovery plan for the northern spotted owl - draft. Portland, OR: U.S. Department of the Interior. 662 p.

Van Sickle, J.; Gregory, S.V. 1990. Modeling inputs of large woody debris to streams from falling trees. Canadian JournM of Forest Research. 20: 1593-1601.

Vannote, R.L.; Minshall, G.W.; Cummins, K.W., [and others]. 1980. The river continuum concept. Canadian Journal of Fisheries and Aquatic Sciences. 40:452-461

Wagner, R.G. 1980. Natural regeneration at the edges of Abies amabilis zone clearcut on the west slope of the central Washington Cascades. Seattle, WA: University of Washington. M.S. thesis.

Ward, B.R.; Slaney, P.A.; Facchin, A.R.; Land, R.W. 1989. Size-biased survival in steelhead trout (*Oncorhynchus mykiss*): back-calculated lengths from adults' scales compared to migrating smolts at the Keogh River, British Columbia. Canadian Journal of Fisheries and Aquatic Sciences. 46: 1853-1858.

Washington State Forest Practice Board. 1992. Standard methodology for conducting watershed analysis under chapter 222-22 WAC (Version 1.10). Olympia, WA: Washington Forest Practice Board.

Williams, J.E. 1991. Preserves and refuges for native western fishes: history and management. Pages 171-189 in: Minckley, W.L; Deacon, J.E., eds. Battle against extinction: native fish management in the American West. Tucson, AZ: University of Arizona Press.

Williams, J.E.; Johnson, J.E.; Hendrickson, D.A., [and others]. 1989. Fishes of North America endangered, threatened, and of special concern. Fisheries. 14(6): 2-20.

Yount, J.D.; Niemi, G.J. 1990. Recovery of lotic communities from disturbance - a narrative review of case studies. Environmental Management. 14: 547-569.

Ziemer, R.R.; Swanston, D.N. 1977. Root strength changes after logging in southeast Alaska. Research Note PNW-306. U.S. Department of Agriculture, Forest Service.